ACTA UNIVERSITATIS SZEGEDIENSIS

ACTA BIOLOGICA

NOVA SERIES

TOMUS XXXIX FASCICULI 1-4

SZEGED (HUNGARIA)
1993

ACTA UNIVERSITATIS SZEGEDIENSIS

ACTA BIOLOGICA

NOVA SERIES

TOMUS XXXIX FASCICULI 1-4

SZEGED (HUNGARIA)
1993

Adjuvantibus
L. ERDÉLYI, L. GALLÉ, K. GULYA, S. GULYÁS, M. KEDVES, I. MÉCS, J. NEMCSÓK, F. ZSOLDOS

redigit
GYULA L. FARKAS

editionem curat
GYÖRGY GYÖRFFY

edit
Facultas Scientiarum Naturalium Universitatis Szegediensis de Attila József nominatae

Nota
Acta Biol. Szeged.

A szerkesztő bizottság tagjai
ERDÉLYI LAJOS, GALLÉ LÁSZLÓ, GULYA KÁROLY, GULYÁS SÁNDOR, KEDVES MIKLÓS, MÉCS IMRE, NEMCSÓK JÁNOS, ZSOLDOS FERENC

Szerkesztő
FARKAS L. GYULA

Technikai szerkesztő
GYÖRFFY GYÖRGY

Kiadja
a Szegedi József Attila Tudományegyetem Természettudományi Kara
(Szeged, Aradi vértanúk tere 1.)

ISSN0324-6523
ISSN 0563-0592
Kiadványunk rövidítése
Acta Biol. Szeged.

ACTA BIOL. SZEGED. 39. pp. 3-22. (1993)

THE ULTRASTRUCTURAL DAMAGE AND CONSEQUENCES OF PANCREATIC EXOCRINE ENDVENTRICLES IN EXPERIMENTAL ENDOTOXIN SHOCK *

S. BENDE, SR. (PENS.)+ and S. BENDE, JR.++

+Teacher Training Faculty of Eötvös Lóránd University, H-1075 Budapest, Kazinczy u. 23-27., Hungary.
++Semmelweis Hospital Department of Surgery, H-3529 Miskolc, Csabai kapu u. 9-11., Hungary

(Received: July 5, 1993)

Abstract

The investigations into the ultrastructural damage of the pancreas in endotoxin shock has so far escaped the attention of researchers. The authors demonstrate in the exocrin cells of the pancreas of dogs, treated of *Escherichia coli* O_{26} endotoxin, such ultrastructural alterations which cannot be observed in case of other organs, after being similarly treated and from which we can draw conclusions concerning the pathomechanism of shock, not made entirely clear until now. It is the most remarkable feature that in the celis no lysosomes resp. Formations referring to some lysosomatic activity are visible; at the same time, there are large vesicles and therein myelin-figures, limited by the outer membrane of mitochondria, in the place of mitochondria. The degradation of mitochondria can, therefore, not be explained with the effect of lysosomal enzymes. The hypothesis of the authors is that the endotoxin getting into the pancreatic cells induces the DNA-RNA systems of the mitochondrium and, consequently, some autolytic ferments are formed and gradually dissolve the proteins of the inner membrane. And the rolledup lipid membranes are arranged into myelin-figures. It may be supposed that during the autolysis of mitochondria vasoactive resp. cell-damaging polypeptides are formed. These shock factors and membrane-toxins, getting into the blood stream, are responsible for the irreversible damage of the shocked organs. - On the basis of our results, the pancreas should be considered as a primary shock-organ.

Key words: pancreas, exocrin ventricles, endotoxin shock, *Escherichia coli*, dog, lysosoma, mitochondrium, myelin-figure.

Introduction

Shock is a complex insufficiency comprising the whole organism. From aetiological point of view, we differentiate between traumatic, haemorrhagic, cardiogenic, anaphylactic and toxic shocks. The endotoxic shocks, elicited by Gram-negative intestinal bacteria, fall within the latter group.

* This paper is dedicated to the centennial anniversary of Prof. AMBRUS ÁBRAHÁM's birth.

The leading clinical symptoms of the endotoxic shock are: the disturbances o: microcirculation and macrocirculation (cardio-vascular insufficiency), coagulopathy, hepatic injury, renal tubules, renocortical necrosis, "shock lungs". The endotoxin shock is - despite the present-day intensive, complex therapy - of a 60 to 80 p.c. letality.

The experimental endotoxin shock can be elicited easily. It is rendered possible by the ultrastructural investigation into the shock organs to study the formation of the irreversible coronary damages, to clear up the causes, pathological processes of shoks. Its importance is considerably high if we approach the opinion of FINE et al. (1959), according to which endotoxins have a part in the pathogenesis of every shock, and even we shouldconsider the endotoxin as the main factor responsible for irreversibility.

Endotoxin contains mor than one kind of toxicants like toxic proteins, N-acetyl-amino-hexuronic acid, lipopolysaccharides (LPS). Its most toxic substances are LPS and among these, as well, the basic units of mean molecular size (3 to 4 million) (BEER et al. 1965).

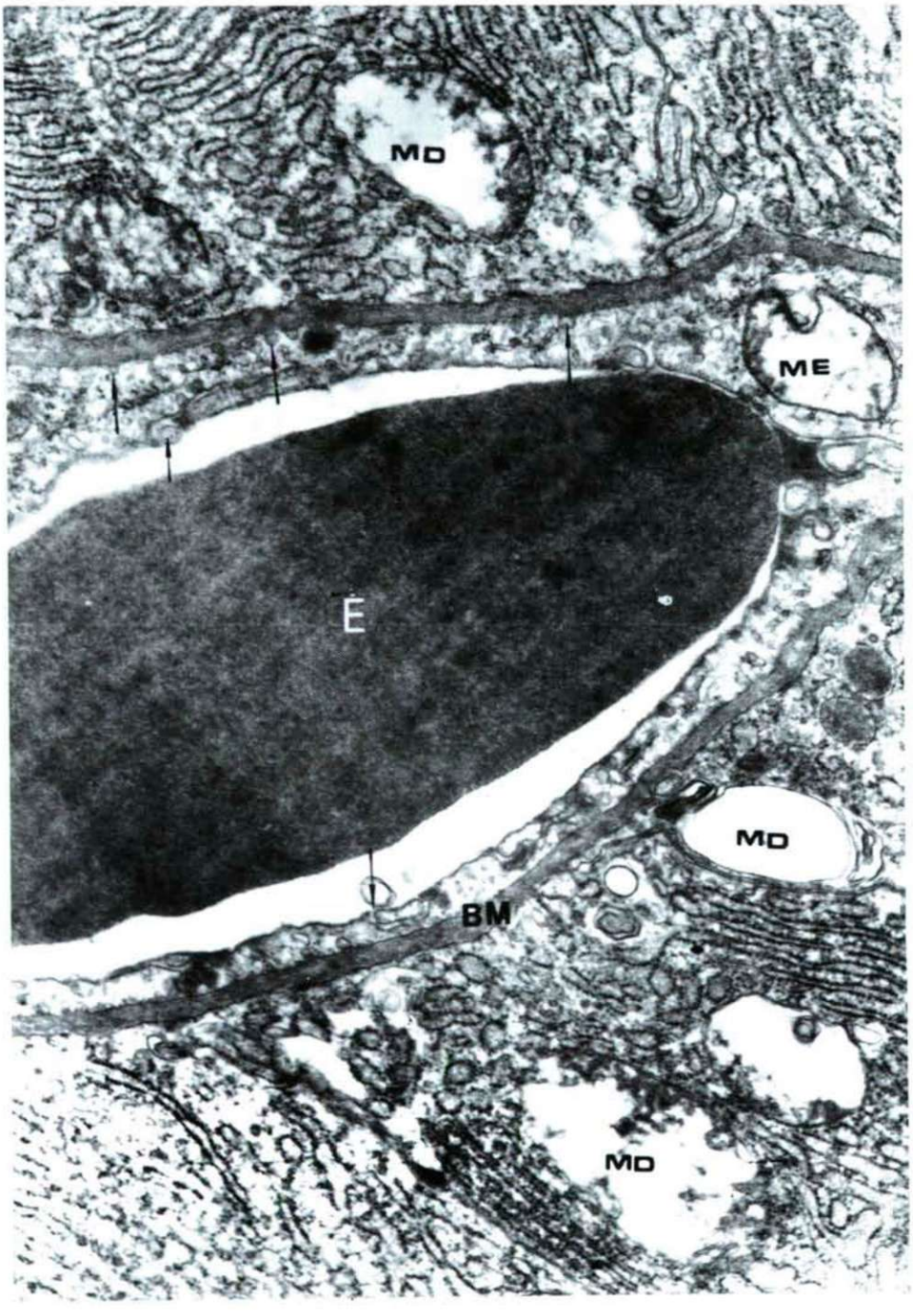
It has long been known, on the basis of experiments performed with fluorescing anti-bodies (AVETIKYAN and KARASIK 1960; ARKADEVA 1963), that toxins get in the cytoplasm through the cell membrane and, after a very short time they can already be demonstrated in the nucleus itself. And even they get over through the membrane of mitochondria, as well. For instance, the filtrate of *Clostridium perfringens*, marked with C_{14}, is exclusively incorporated, according to ELLINGER (1961), in the mitochondria of liver.

The bondage conditions of the receptors of the different cells and endotoxins is not known, as yet. It cannot be said, "which the cell types are to be considered as primary targets" (BERTÓK 1978).

The literature of lightmicroscopical researches, dealing with the effect of endotoxin shocks, is rich. So much the more pitiable are the electronmicroscopical histological data. The mostly investigated "shock-organ" of high priority is the liver (BOLER et al. 1969; MC KAY et al. 1967; DE PALMA et al. 1967; LEVY et al. 1968). The cause of this - demonstrated long ago by BRANDIS et al. (1954); DOERLING et al. (1959) - is probably that two hours after the i.v. injection of the endotoxin, 72.2 p.c. of the injected endotoxin is to be found in the liver.

It is surprising that the researchers have not dealt with the effect of endotoxins, made on the ultrastructure of the pancreas. We consider, therefore, as important to discuss our work, as well as to draw the conclusions from our results.

Fig. 1. Exocrine end-ventricle of a canine pancreas. Capillary (endotoxin). E=erythrocyte; BM=membrana basalis; ME=mitochondrium of the endothelial cell; MD=degraded mitochondrium of the exocrine cell; arrows=pynocytotic and exocytotic vesicles. x22500.


MD
ME
E
MD
BM
MD

Material and methods

Our experimental programme began in the Spring of 1980, in the Veterinary Institute in Miskolc, with dogs. In order to observe the physiological parameters, we canulated in Ketalar-narcosis the aorta through the arteria femoralis and the lower empty vein through the vena femoralis. The endotoxin with *Escherichia coli* O_{26} was introduced in infusion similarly through the vena femoralis.

In the first three dogs, the 100 p.c. lethal dose was titrated. This corresponded to 20 ml/body weight kg endotoxin suspension resp., after determining the dry substance, to 30 mg/body weight kg *E. coli* O_{26} endotoxin quantity.

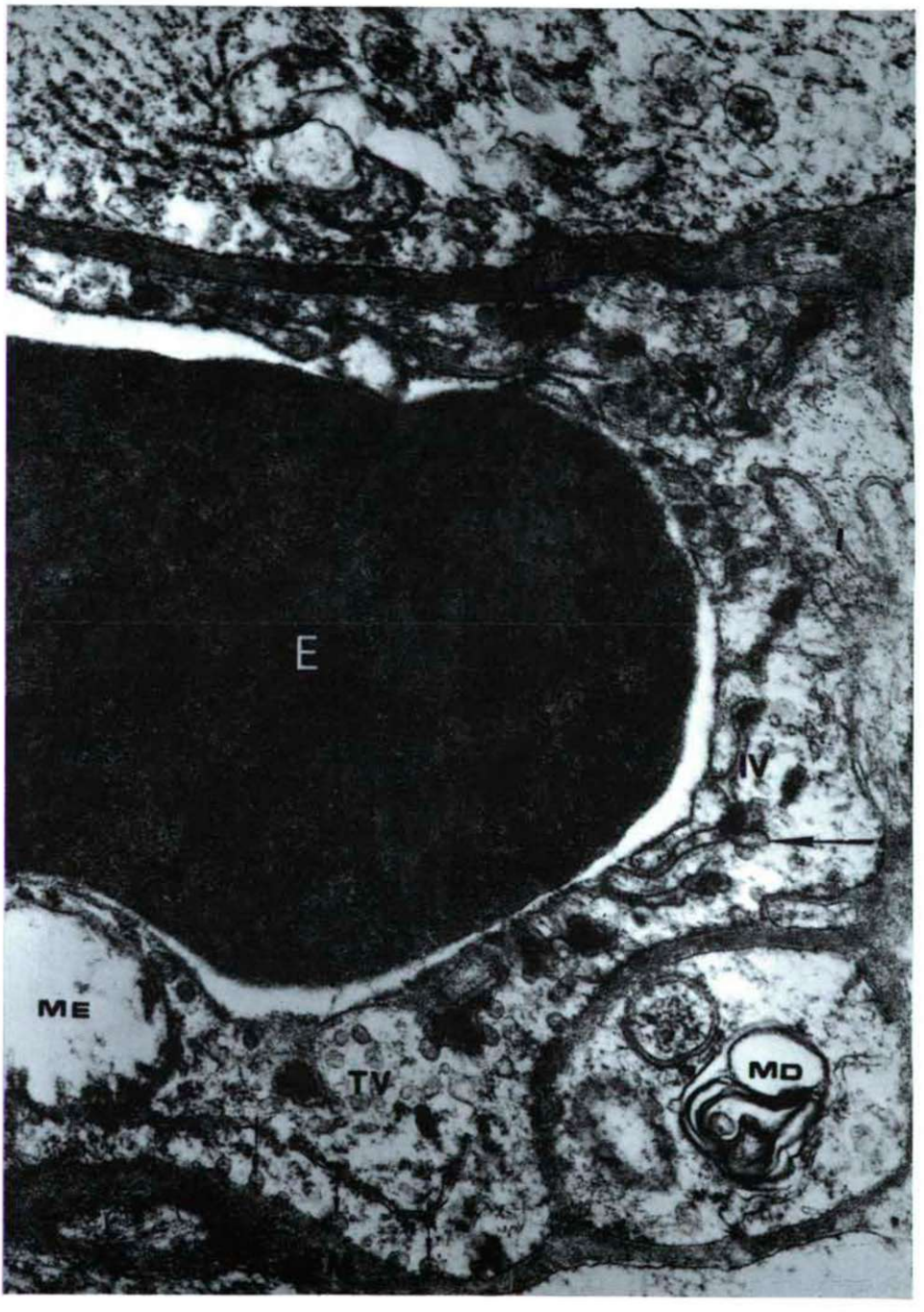
The next occasion, we examined the direct arterial pressure, the central venous pressure, the pulse and respiratory rates on three dogs poisoned with a 100 p.c. lethal dose and on two control dogs each. Then we performed the routine examinations, determined the differences in coagulation and blood gases. After the death of dogs (4 resp. 5 hours), resp. following the over-anaesthesia of control dogs, some substance was taken from the then "usual" organs (liver, kidney, lungs, heart, duodenum) for light- and electron-microscopical investigations. Then we thought of that the entero-bacteria may, by all means, have an effect on the pancreas. Thus, the samples taken from the pancreas were also fixed.

The lightmicroscopical substance was fixed in Bouin, and embedded - after dehydration and treatment with methylbenzoate - in paraffin. The sections were stained with Weigert's haem.-eosin and Mallory. The electronmicroscopical substance was fixed in 2.4 p.c. glutaraldehyd + 0.1 M Na-cacodilate buffer, later in 1 p.c. OsO_4, buffered similarly with Na-cacodilate. The dehydration was performed in alcohol series and acetone. The substance was embedded in araldite. The sections were made in the Department of Zoology of the Eötvös Lóránd University with ultramicrotome Reichert OM U2 and investigated at the same place with an electronmicroscope of Type Tesla BS 500. For supporting our work, we are indebted to reader and head of department Dr. JÁNOS KOVÁCS and for his expert advices of great value, to reader LAJOS KONDICS.

Results

The capillaries of the exorcine end-ventricles of the pancreas show the change, characteristic of the endotoxine effect. In their lumen there are stagnating erythrocytes. The basal membrane of the endothelial cells is disproportionately thick but, in respect of its function, it is rather "loosened". In the loose membrane the pinocytotic vesicles almost reach to one another. Between the plasmic membranes of the adjacent endothelial cells some delated interdigital gaps are visible. The cytoplasm is full of transport vesicles. These stream towards the deep invaginations of the plasmic membrane, facing the vascular lumen, and then evacuate with exocytosis into

Fig. 2. Exocrine end-ventricle of a canine pancreas. Capillary (endotoxin). E=erythrocyte; BM=membrana basalis; TV=transport vesicle; IV=invaginatio; I=interdigital gap; ME=endothelial cell mitochondrium; MD=autolytic mitochondrium of an exocrine cell; arrows=pynocytotic and exocytotic vesicles. x39000.


E
IV
ME
TV
MD

the lumen of the capillary. In the endothelium of the capillary take, therefore, place very intensive metabolic processes. The mitochondria of endothelial cells were, as a consequence of the high-degree hypoxia, degraded, but there are no myelin-figures in their places (Figs. 1. 2.).

As a result of endotoxin, a certain disturbance manifests itself in the secretory processes of cells. This is demonstrated by the difference in form and size between the praezymogenous and zymogenous granules, being a little electron dense and visible in large number in the apical part of cells, as well (Fig. 3.).

It is very characteristic that the ultrastructure of exocrine cells of the pancreas, treated with endotoxin, with the exception of mitochondria, shows no full degradation, even if death comes. On the cell nucleus, no particular changes are to be seen, the cell nucleus is healthy - the pores are a little wider. The Golgi-system is preserved, the granular endoplasmatic reticulum (ER) is only partly damaged. The secretory processes do not come to a standstill. The forms of cell connection (junctions, interdigital connections) are hardly wider (Fig. 4.).

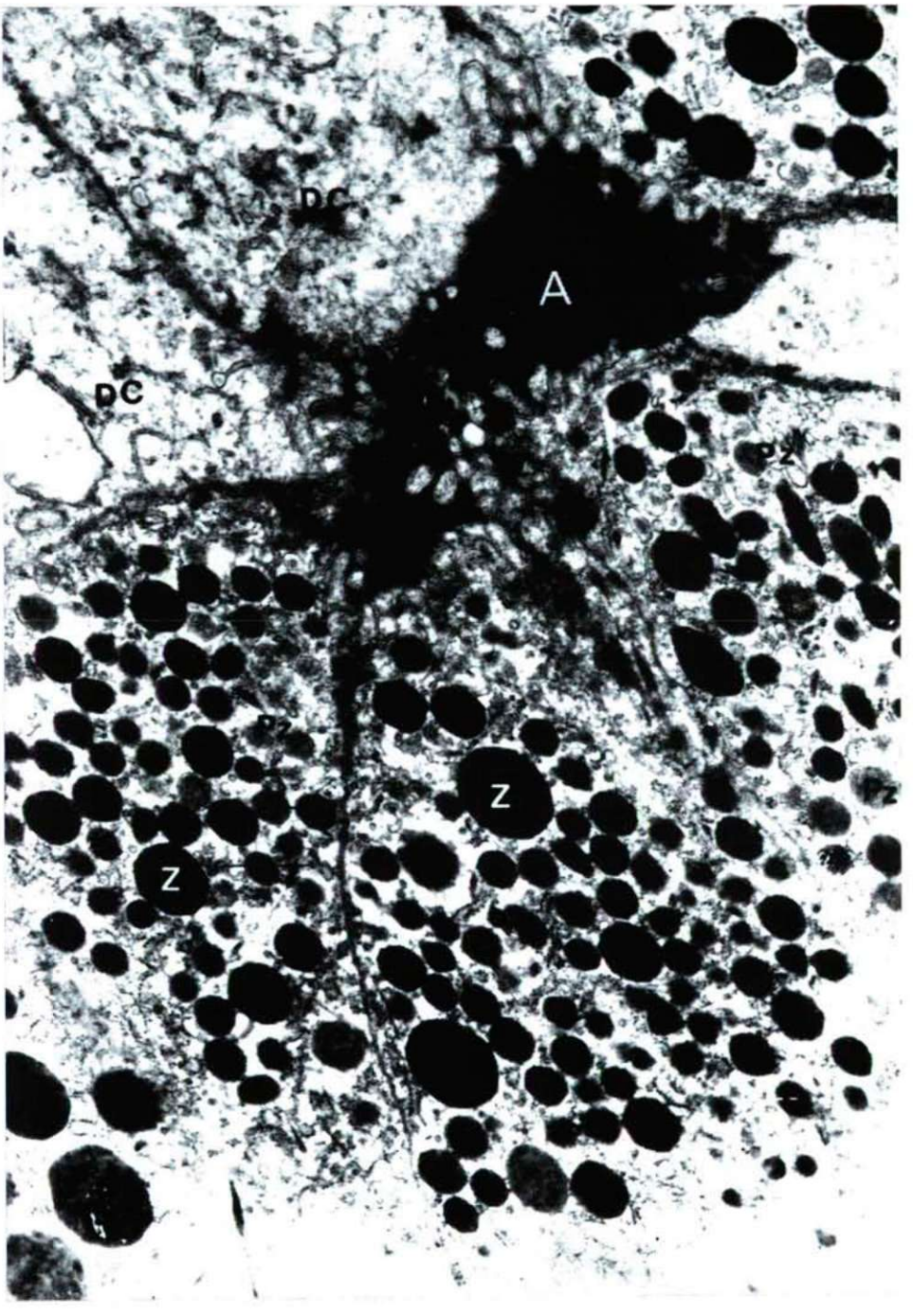
There cannot be observed any primary, secondary lysosome formation. And even, the lack of residual bodies of lysosomal origin refers to that there was no noticeable lysosomal activity in the cells, during the whole endotoxic treatment, either.

The cisterns of the granular endoplasmatic reticulum show the regular laminar picture, which is generally characteristic of the healthy pancreas but - mainly close to mitochondria - they widen out strongly, are vascularized, containing a somewhat electron-dense, finely garnular, lipid-like substance, which may supposedly be LPS (endotoxin), having got in the endoplasmatic system (Figs. 5. 6.).

In cells, apart from rare exceptions, there is no intact mitochondrium! As a result of the substance (endotoxin?), coming out of the cisterns, opened vesicles of the endoplasmatic reticulum, the space between the two membranes grows namely continuously and in the meantime, the dissolution of the cristae of the inner membrane begins. Finally, there remains in the place of the mitochondrium the vesicle, limited by the outer membrane and, inside of it, a huge myelin-figure. (The autolysis of mitochondria, resp. the formation of the myelin figures is clearly shown by Figs. 4, 5, 6 and 7).

Figure 8 is showing the direct contact between the cistern of dilated the endoplasmatic reticulum and the mitochondrium. And in Fig. 9, we can observe the invasion of a huge LPS-drop, accumulated after cracking of the endoplasmatic reticulum in a mitochondrium.

Fig. 3. Exocrine end-ventricle of a canine pancreas (endotoxin). A=acinus; Z=zymogenous granule; Pz=prezymogenous granule; DC=degraded cells. x18000.


DC
A
DC
Z
Z
Z

Discussion

In case of animals in endotoxin shock, the myelin-figures appearing only in the pancreas attrack the attention to the pathomechanism of the endotoxin shock, give an explanation for its course which is more serious than any other kind of shocks, and also for its death rate showing high percent.

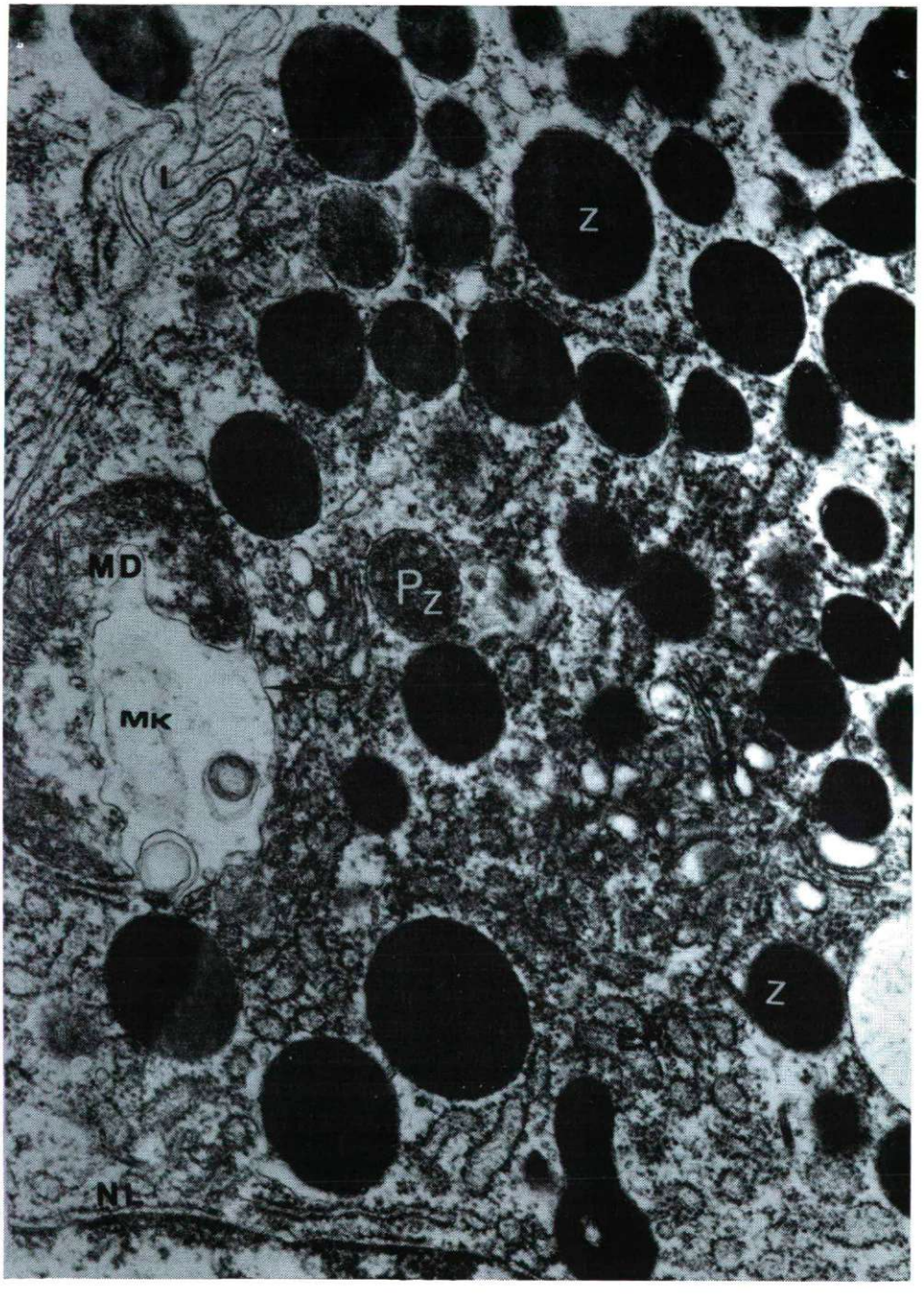
After recognising the effect of the lysosomial enzymes (WEISMANN and THOMAS, 1962, 1964; JANOFF et al., 1962; JANOFF, 1964; DE PALMA et al., 1967; LAPIS, 1974) on the basis of the results of physiological, biochemical and electronmicroscopial examinations a new theory has been found, according to which for the irreversibility of the shocks the lysosomial enzymes activated in the hypoxaemial and acidotic cells are responsible, which in their place of formation, in an autolytical way cause the sinking and at last the death of cell. Among the organs, the most deeply influenced liver, the kidney and the lungs have been considered as primary shock-organs.

The attention has been drawn to the connection between the pathological function of the pancreas and the effect of the endotoxins from the 1970-ies. The works of FINE (1975), FLENKER and LIEHR (1978), LIEHR et al. (1980), SEIFERT (1970), LEFER (1974), GLENN and LEFER (1970) pointed out that a connection has to be searched for between the function of the shocked pancreas, the endotoxaemia and the irreversibility of shocks. FINE (1975) presupposed that in pancreatitis endotoxins can get transmurally from the colon to the circulation and they have biological activity there. It has been confirmed by LIEHR and his colleagues, who could detect the endotoxaemia in pancreatitis by Limulus-test. They found that the extrahepaticus complications, such as clotting troubles, renal insufficiency, lesions of the lungs, and even death, have appeared only in those cases, when the endotoxaemia could have also been detected. FLENKER and collaborators, LIEHR and his colleagues, LEFER, GLENN and LEFER found as the role of pancreas in the process of the development of the irreversibility, that from the shocked pancreas exocrin cells shock-specific mediators (MDF - miocardial depressant factor) could evolve, which could cause the hurt of the heart, the lungs and other organs.

MELA et al. (1970, 1981) mention some kind of "membrane toxins", which are formulated by the participation of mitochondria in endotoxaemia and in tissue hypoxaemia, and hurt the biological membranes.

MORI et al. (1981) examined the effect of lysosomial enzymes with normal rats and also with rats treated with endotoxins. The enzymes given either intravenously or intraperitoneally have not caused haemodynamical changes neither with the normal, nor with those animals which have been treated with a letalic endotoxin dose. Also the combined use of the endotoxin and the lysosomial enzymes have not influenced the

Fig. 4. Exocrine cell of a canine pancreas (endotoxin). I=interdigital gap; Z=zymogenous granule; Pz=prezymogenous granule; MD=degraded mitochondrium; MK=outer ventricle of a mitochondrium; arrow=outer membrane of a mitochondrium; ER=granular endoplasmatic reticulum; NL=nuclear membrane. x39000.


I
Z
MD
Pz
MK
Z
NL

circulation and the mortality of the treated animals. Finally they pointed out: - their experimental data have run counter to that in endotoxin shock the lysosomial enzymes got into the circulation would have had a significant role in the development of the irreversibility of the shock.

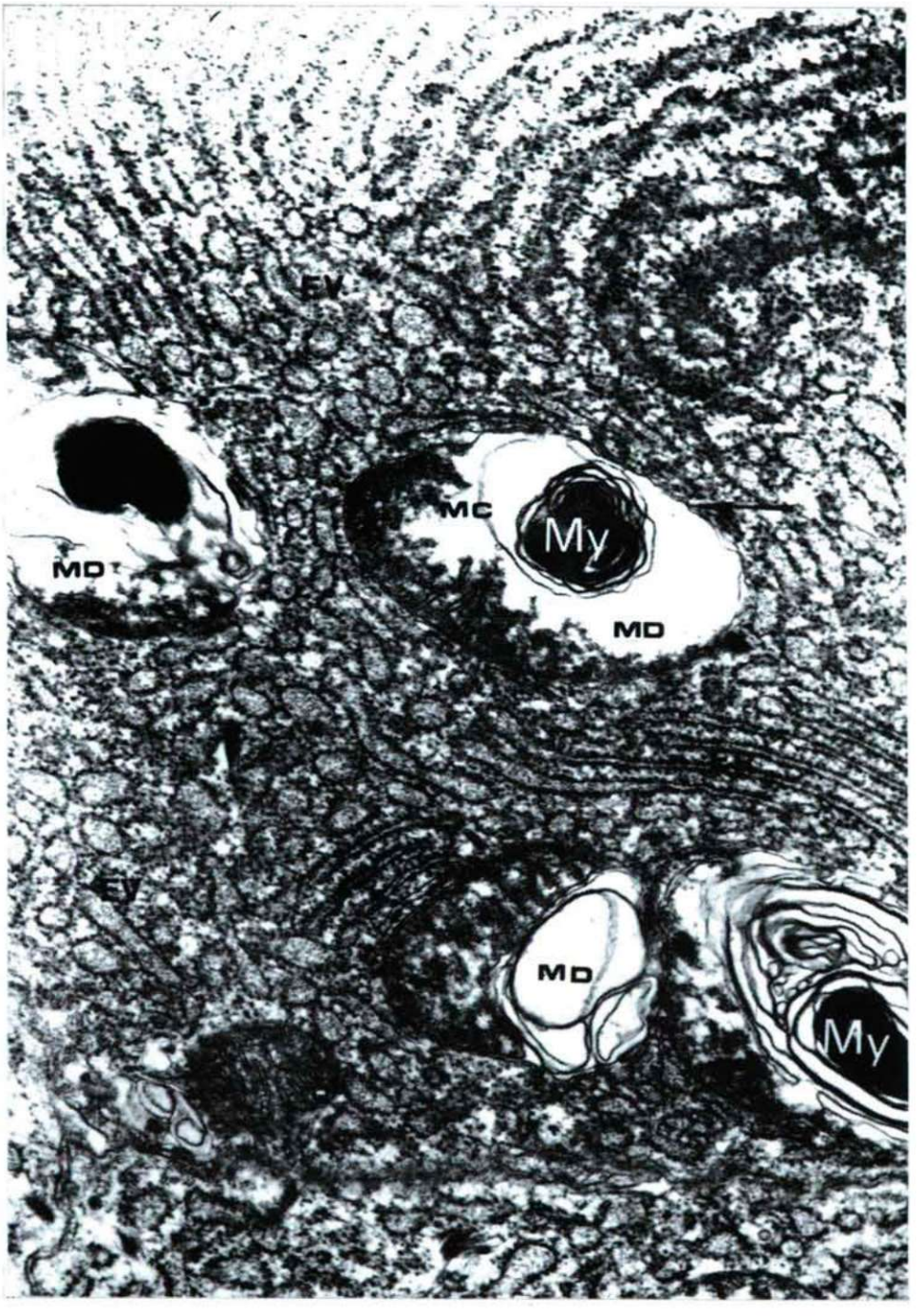
In spite of the connection of clinical importance between the pathological state of the pancreas and the endotoxaemia, we only know the study of NAYYAR et al. (1985) about the ultrastructural lesions of the endotoxin shocked pancreas. The aim of their examination was to study the autophagia in the liver, the kidney and the pancreas of 10-day-old rats. They found that autophag vacuolums were formed in the pancreas as the effect of the endotoxin. These could get into membrane-fusion with the mitochondria, and as a consequence secondary lysosomes bounded by simple membrane and residual bodies were formulated. We have not seen such phenomena in the exocrin cells of the pancreas of neither dogs nor rats. During the formation of the myelin-figures, we have never seen the fusion of the mitochondrium membranes with the membranes of other cell-organells. Moreover it can be clearly observed as the inner membrane moves away from the unhurt outer membrane and after it the cristolysis is beginning.

In our case what is important is the primary change caused by the endotoxin, the conditions of the formation of secondary bodies cannot be seen.

During our experiments, we kept the animals alive generally for 4 hours. Within this period of time the ultrastructure of the pancreas exocrin cells has been scarcely changed with the exception of the mitochondria. We have not met bigger necrosis or focalis described at shocks of other origin. In endotoxin shock in the exocrin cells of the pancreas of dog the inner membrane-system of the mitochondria has been degraded and myelin-figures have been formulated in the bladders bounded by the outer membrane of the mitochondrium. We cannot consider them as growths on the effect of hypoxaemia or acidosis, but they cannot be the result of lysosomial enzyme activation as well, as in the cells the number of the lysosomes does not grow, residual bodies cannot be found there, and on the other hand the free lysosomial enzymes would have hurt the other organelums of the cell. As we have not found such things, we presuppose that the endotoxin directly effects the mitochondria of the pancreas exocrin cells. On its effect the albumin components of the inner membrane-system are resolving an enzymatic way, and the residue lipids become myelin-figures.

The myelin-figures are often considered as artificial results, or simply as precipitates and for their formation mainly the glutaraldehyd fixation is made responsible. The myelin-figures in our pictures can hardly be called precipitations, especially when the gradual cristolysis and the growth of lipid-lamellas can be observed step by step on the mitochondria. On the other hand they were formulated

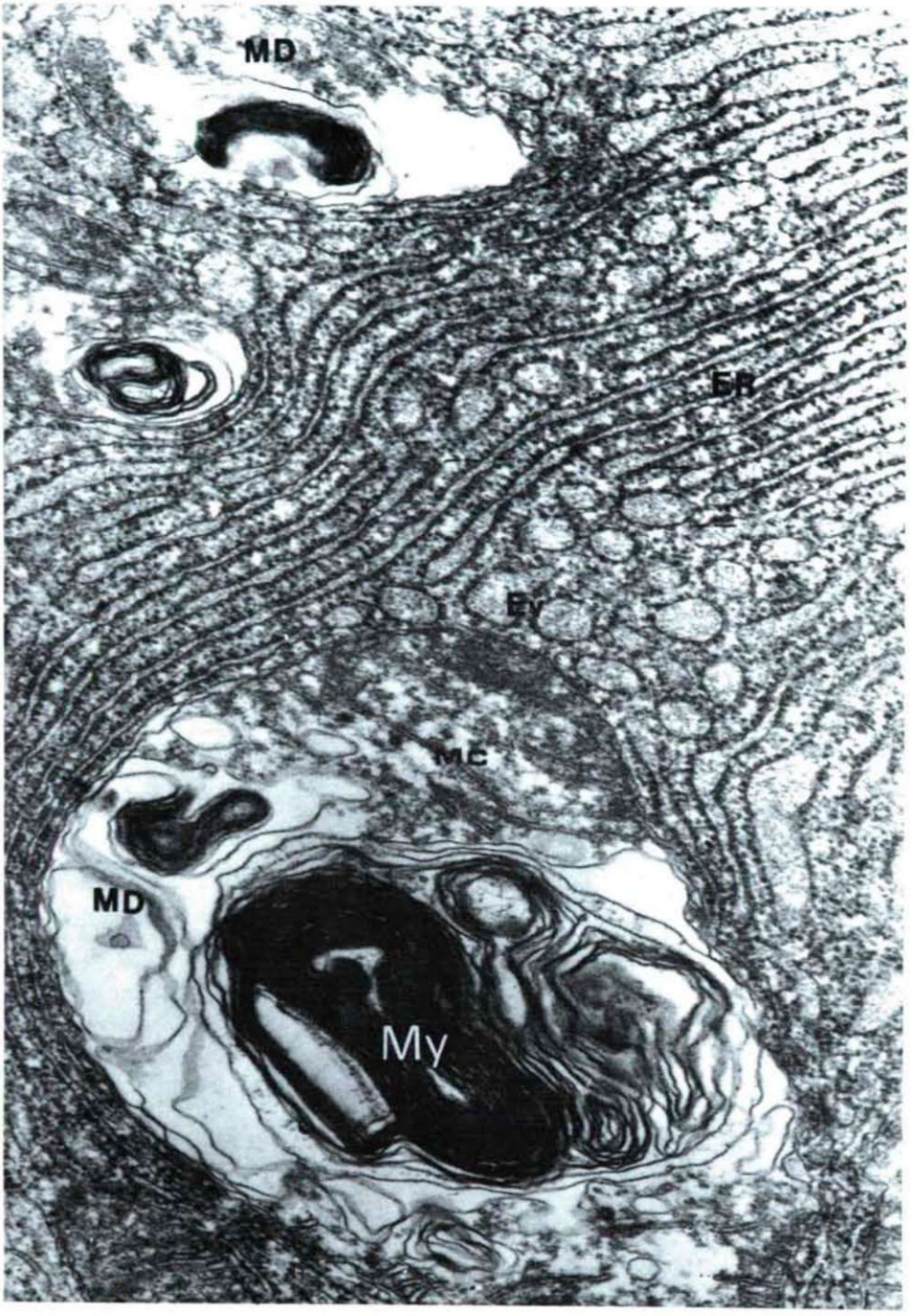
Fig. 5. Exocrine cell of a canine pancreas (endotoxin). EV=vesicularized endoplasmatic reticulum; ER=laminar endoplasmatic reticulum; MD=degrading mitochondrium; MC=crista mitochondrialis; My=myelin-figure; arrow=outer membrane of a mitochondrium. x39000.


EV
MC
My
MD
MD
EV
MD
My

only in the endotoxin shock and only on the mitochondria of the pancreas exocrin cells. They do not appear neither in the cells of other organs, nor in the mitochondria of haemorrhagial shocked pancreas exocrin cells examined as control, though those samples of organs were taken fromdogs and were fixed with glutaraldehyd.

Our hypothesis is supported by the biochemical observations of MCGIVNEY and BRADLEY (1979), BRADLEY (1981) and MELA (1981). BRADLEY presupposes that the endotoxin can get into the cell by endocytosis and the endocytotic vacuolum can merge with a primary lysosome, and also with mitochondrium membrane. So the toxophor can be placed to the receptor in the membrane of the mitochondrium and as its result, within 2-4 hours, the endotoxin can cause an important change in the function of the enzymes of the inner membrane-system. He presupposes that the endotoxin and the lipid-A component simultaneously effect in the inter-membrane space of the mitochondria, in the matrix and on the enzymes found in the inner membrane. MELA caused endotoxaemia and septicaemia in guinea-pigs and dogs, and examined the functions of the mitochondria. He found that the ATP-synthesis, the Ca-transport and the mitochondrial breathing have sufficiently decreased. As he presupposed that these changes can also occur in hypoxaemic state, he repeated the experiments with isolated mitochondria, and he found that the previous processes have decreased more sufficiently. He proved that the trouble in the function of the mitochondria is in direct proportion to the irreversibility and thus to the mortality. Our experiments and electronmicroscopial observations show, that in endotoxin shock the hurt of the pancreas mitochondria can be recognized very soon, after about 30 minutes, so it cannot be expected that the seriously damaged mitochondria will be able to regenerate on the effect of a contingent sudden stop of shock. The destruction of the mitochondria of the pancreas exocrin cells can cause a trouble in the secretional function. The pathological factors, the so-called "shock-factors", getting into the circulation play a part in the serious ultrastructural lesion of other organs and help their irreversible hurt. This kind of function of the endotoxin shocked pancreas has been proved by the animal experiments of SUZUKI et al. (1978). They caused shock on hares by bleeding and partial liver-necrosis (binding of art. hepatica). At a part of the hares the ductus pancreaticus has been bind 10 weeks before, so the pancreas became fibrosical. In the shock caused by partial liver-necrosis, with animals with unhurt pancreas, the perfusion of the brain, heart, the kidney, pancreas, liver and splanchnicus territory has decreased drastically, while in the hares with fibrosical pancreas the circulation of each organ has remained almost normal. The differences indicate that the pancreas has an important role in the development of the shock. From the fact that in case of pancreas fibrosis, in shock, the splanchnical circulation remains normal the authors draw the conclusion that besides the ischaemia other fasctors also play a part in the release of shock-factor from the pancreas. We think that this factor is the endotoxin which got into the splanchnicus circulation and the pancreas.

Fig. 6. Exocrine cell of a canine pancreas (endotoxin). ER=laminar endoplasmatic reticulum; EV=vesicularized endoplasmatic reticulum; MD=degrading mitochondrium; MC=crista mitochondrialis; My=myelin-figure. x39000.


MD
ER
Ly
MC
MD
My

From the cross-checks of the results of our ultrastructural examinations and the data from the above mentioned literature, we can draw the following theoretical and practical conclusions:

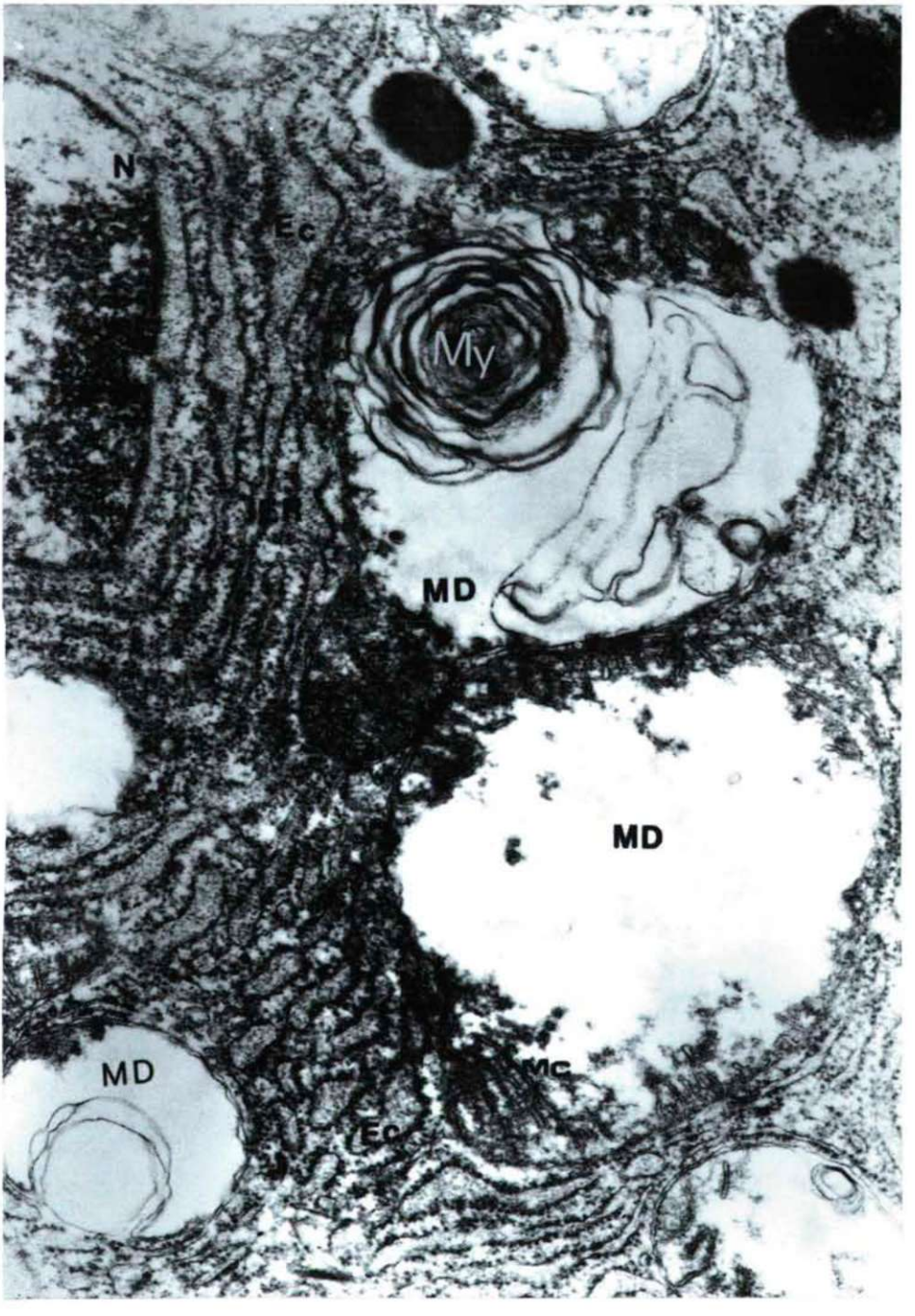
- As the myelin-figures appear only in the pancreas exocrin cells, we could use the pancreas exocrin cells as a model for the evaluation of the endotoxin effect found in other organs.
- We used them as a model for proving the differences in the pathomechanism of the shocks and on its basis proving the direct cell-damaging role of the endotoxins.
- We could examine the effectiveness of different therapeutic processes on sub-cellular level.
- The formation of the myelin-figures, the lack of lysosomial residue bodies prove that it is not the lysosomial enzyme which is responsible for thi high irreversibility of the endotoxin shock, but the endotoxin is, and the processes indicated by the endotoxin.
- The pancreas is a primary shock-organ, moreover, on the basis of the myelin-figures formulated only in the pancreas exocrin cells and its simultaneous patho-physiological processes it can be presupposed that the membranes bounding the mitochondria of the pancreas exocrin cells are the "target" membranes of the endotoxin.
- In agreement with the opinion of many authors, according to which during the development of the myelin-figures, different membrane destructive factors, membrane toxins, opioids, complement activators etc. are formulated, which can effect the different organs, and the endotoxin and the pancreas may have an effect on the final evolvement of every kind of shocks.
- The anoxia, acidosis, formulated by the sympatho-adrenalis system, and as its result the destructive effect of the lysosomial enzyme-system on the organs definitely play a part to a certain extent in the pathomechanism of the endotoxin shock, but from the myelin-figures appearing in the pancreas exocrin cells in the very early phase of the endotoxin shock we can draw the conclusion that in the pathophysiological processes of the endotoxin shock the pancreas has a determinal role.

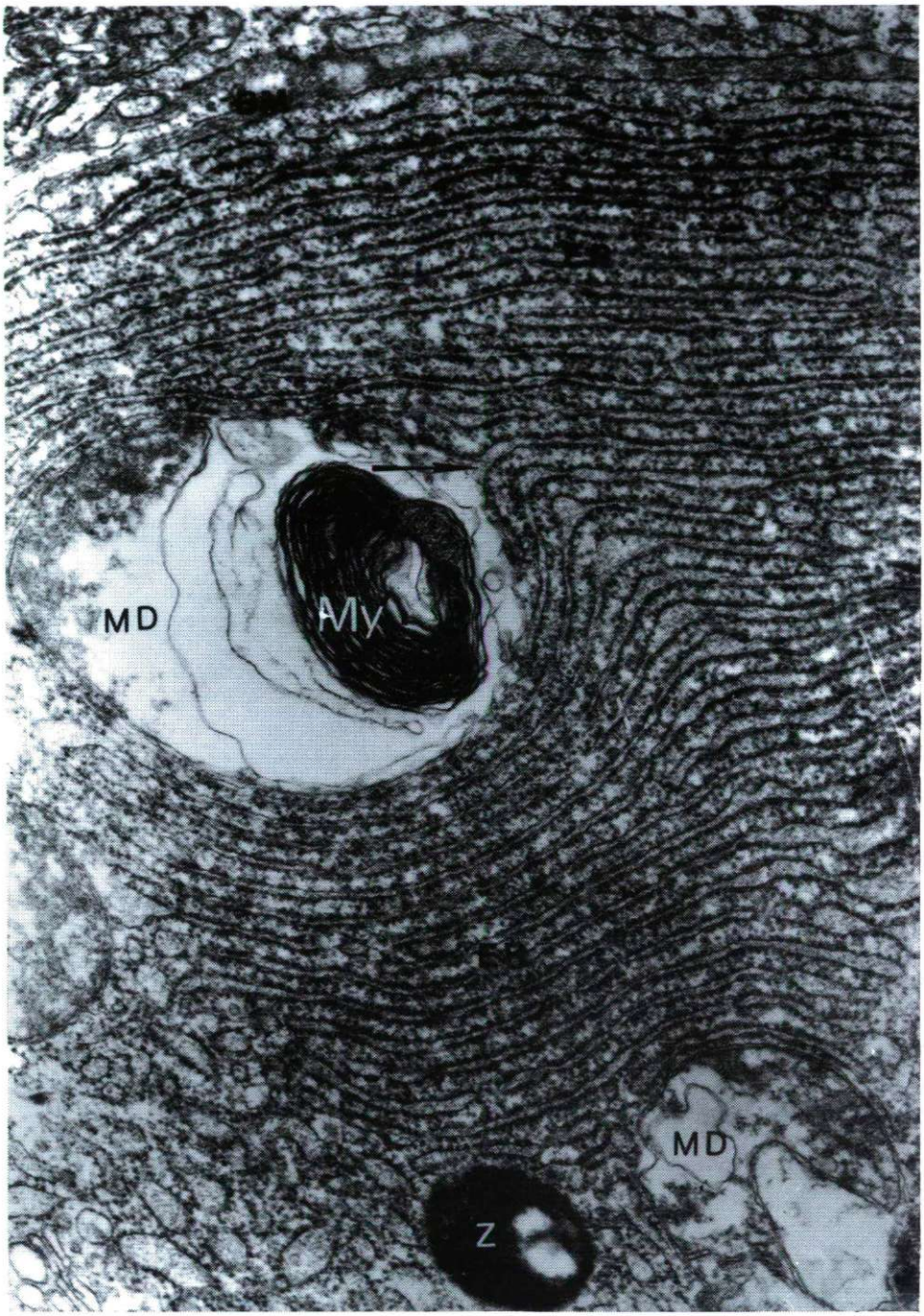
Fig. 7. Exocrine cell of a canine pancreas (endotoxin). ER=laminar endoplasmatic reticulum; Ec=delated cistern; MD=degrading mitochondria; MC=crista mitochondrialis; N=nucleus. x39000.

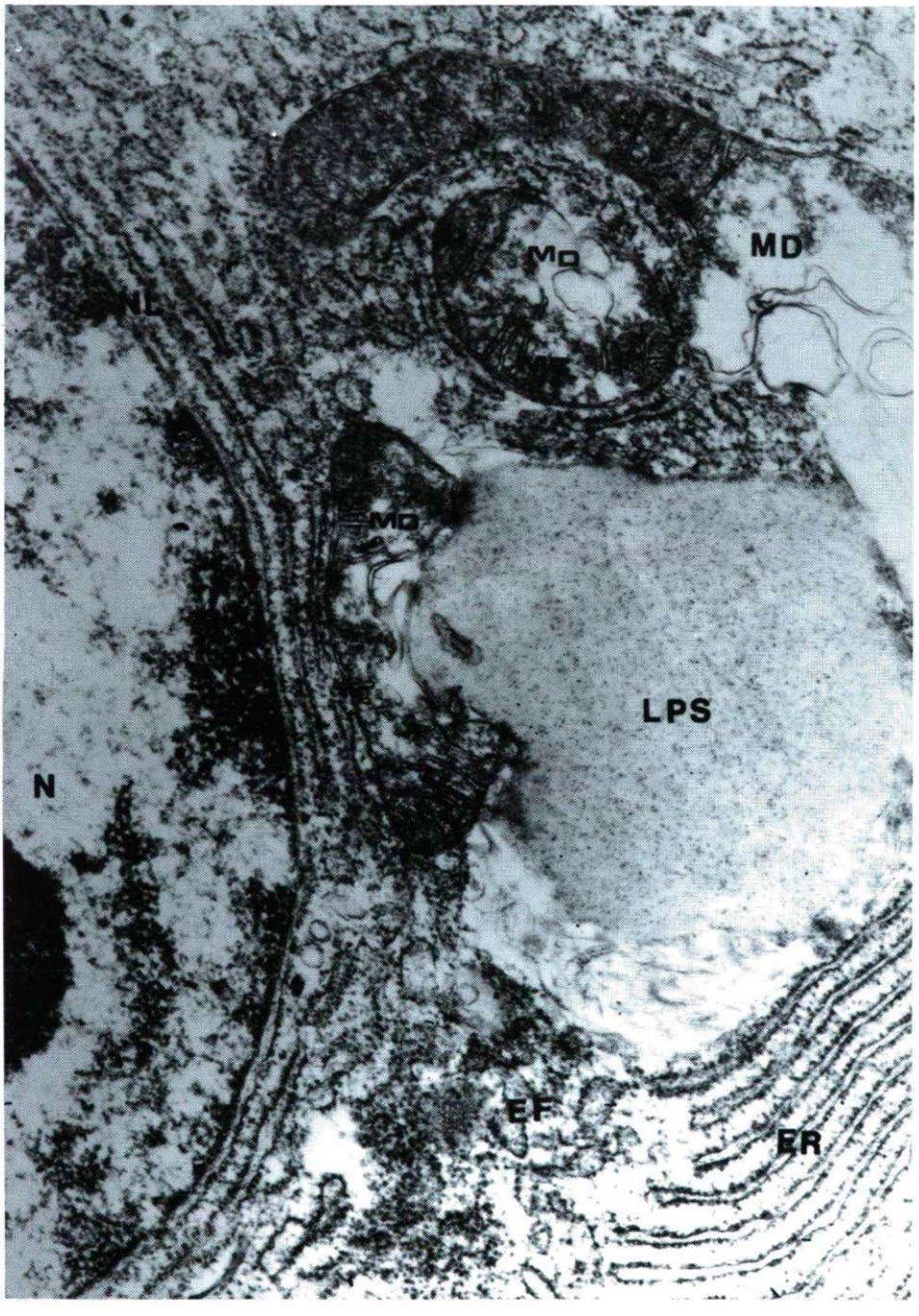
Next two pages:

Fig. 8. Exocrine cell of a canine pancreas (endotoxin). BM=membrana basalis; ER=laminar endoplasmatic reticulum; MD=degrading mitochondrium; Z=zymogenous granule; My=myelin-figure; arrow=direct contact between delated cistern and the mitochondrium. x39000.

Fig. 9. Exocrine cell of a canine pancreas (endotoxin). MD=degrading mitochondria; MC=crista mitochondrialis; LPS=lipopolysaccharid drop?; ER=endoplasmatic reticulum; EF=cracked endoplasmatic reticulum; N=nucleus; NL=nuclear membrane. x39000.


N
EC
My
MD
MD
MD
MC
EC


MD
My
MD
Z


MD
MD
MD
LPS
N
EF
ER

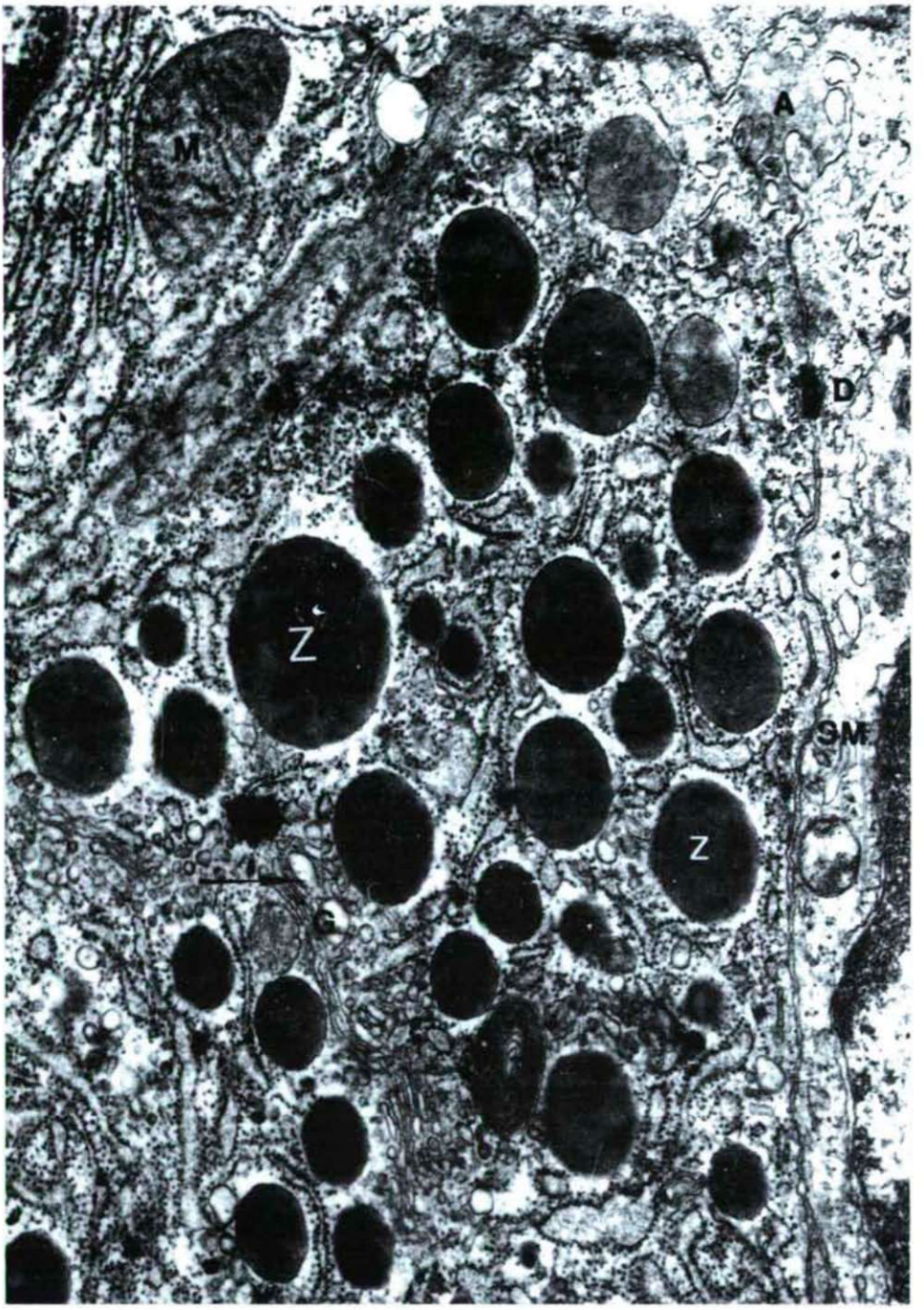

M
A
D
Z
SM
Z

Fig. 10. Exocrine cell of a canine pancreas (control). A=acinus; M=mitochondrium; ER=granular endoplasmatic reticulum; G=Golgi-system; arrow=Golgi vesicle; Z=zymogenous granule; D=desmosoma; SM=cell membrane. x22500.

References

BANG, F.B. (1956): A bacterial disease of *Limulus polyphemus*. - Bull. Hopkins Hosp. *98*, 325-328.

BENDE, S. (1986): Szeptikus shock a sebészetben (Septic shock in surgery). - Orvosképzés *55*, 343.

BENDE, S. sr. and BENDE, S. jr. (1989): Kísérletes haemorhagiás és endotoxin sokk hatásának összehasonlító vizsgálata kutyák zsigeri szervein (Comparative ultrastructural study of the effects of experimental haemorrhagic and endotoxin shock on the visceral organs of dogs). - Állattani Közl. *75*, 11-27.

BERTÓK, L. (1978): Biológiai membránok szerepe az endotoxin sokk patogenesisében (Role of biological membrans in the pathogenesis of the endotoxin shock) - MTA Biol. Oszt. Közl. *21*, 169-174.

BOLER, R.K., BIBIGHAUS, A.J. and BRUNSON, J.G. (1967): Ultrastructural alterations of dog livers during endotoxin shock. - Lab. Invest. *17*, 537-561.

BRADLEY, S.G. (1981): Direct action of bacterial endotoxin on cells mitochondria and lysosomes. - In: MAJDE, J.A. and PERSON, R.J. (eds.): Patophysiological effects of endotoxins at the cellular level. Progress in clinical and biological research. Vol. 62. p. 3. Alan R. Liss Inc. New York.

DAVID, H. (1967):Elektronmikroscopische Organpathologie. - Veb Verlag Volk und Gesundheit, Berlin.

DAVID, H. (1970): Zellschädigung und Dysfunktion. - In: Protoplasmatologia Bd. X. Springer Verlag.

DOERLING, F. and FRISE, E. (1959): Z. Ges. Exp. Med. *132*, 328-333.

ELLINGER, P.D. (1961): J. Bact. *82*, 275-283.

FADEN, A.I. and HOLADAY, J.W. (1980): Experimental endotoxin shock: The pathophysiologic function of endorfins and treatment with opiate antagonists. - J. Infect. Dis. *142*, 229-238.

FINE, J., FRANK, E.D., RAVIN, H.A. and RUTENBURG, S.H. (1959): The bacterial factor in traumatic shock. - New Engl. J. Med. *260*, 214-220.

FINE, J. (1975): Acute pancreatitis. The Lancet. *1*,1092.

FREUDENGBERG, N. (1978): Endothelium and shock. - Path. Res. Pract. *162*, 105-114.

FLENKER, H. and LIEHR, H. (1978): Shockmanifestation in Magen, Darm, Pancreas und Leber. Klinik und Pathologie. - In:Verhandlungen der Deutschen Gesellschaft für Pathologie *62*. Tagung. Gustav Fischer. Verlag, Stuttgart, New York. 127-147.

FREUND, H., EBEID, A.M. and FISCHER, J.E. (1981): An increase in vasoactive intestinal peptide levels in canine endotoxin shock. - Surg. Gynec. Obstet. *152*, 604-606.

GLENN, T.U. and LEFER, A.M. (1970): Role of lysosomes in the pathogenesis of splanchnic ischemia shock in cats. - Circ. Res. *27*, 783-797.

HRUBAN, Z., SWIFT, H. and WISSLER, R.W. (1962): Analog induced inclusions in pancreatic acinar cells. - J. Ultrastruct. Res. *7*, 273-285.

ANOFF, A., WEISSMANN, G., ZWEIFACH, B.W. and THOMAS, L. (1962): Pathogenesis of experimental shock. IV. Studies of lysosomes in normal and tolerant animals subjected to lethal trauma and endotoxin. - J. Exper. Med. *116*, 451-466.

ANOFF, A. and ZWEIFACH, B.W. (1964): Production of inflammatory changes in microcirculation by cationic proteins extracted from lysosomes. - J. Exper. Med. *120*, 747-765.

ISZELJOV, P.N. (1978): A fertőző folyamatok toxikológiája (Toxicology of infectious processes). - Medicina, Budapes. pp. 1-360.

LAPIS, K. and SCHAFF, Zs. (1974): A sejtek ultrastruktúrája shockban (The ultrastructure of cells in shock). - In: A traumás shock diagnosztikájának és therápiájának időszerű kérdései (Timely problems of diagnostics and therapeutics of traumatic shock). Akadémiai Kiadó, Budapest. pp. 201-221.

LEFER, A.M. (1974): Myocardial depressant factor and circulatory shock. - Klin. Wschr. *52*, 358-370.

LEVY, R., SLUSSER, R.J. and RUEBNER, H.H. (1968): Hepatic changes produced by a single dose of endotoxin in the Mouse. - Amer. J. Path. *52*, 477-490.

LIEHR, H., GRÜN, M., THIEL, H., BRUNSWIG, O. and RESENACK, U. (1975): Endotoxin-induced liver necrosis and intravascular coagulation in rats enhanced by porto-canal collateral circulation. - Gut. *16*, 429-436.

MCGIVNEY, A. and BRADLEY, S.G. (1979): Action of bacterial endotoxin and lipid-A of mitochondrial enzyme activities of cells in culture and subcellular fractions. - Infect. Immun. *26*, 664-671.

MCKAY, D.G., MARGARETTEN, W. and CSAVOSSY, I. (1967): An electronmicroscope study of endotoxin shock in *Rhesus* monkeys. - Surg. Gynec. Obstet. *15*, 825-832.

MELA, L. BACALZO, L.V, WHITE, R.R. and MILLER, L.D. (1970): Shock induced alterations on mitochondrial energy-linked functions. - Surg. Forum *21*, 6-8.

MELA, L., MILLER, L.D., DIACO, J.F. and SUGERMAN, H.J. (1970): Effect of *E. coli* endotoxin on mitochondrial energy-linked functions. - Surgery *68*, 541-549.

MELA, L. (1981): Direct and indirect effect of endotoxin on mitochondrial function. - Prog. Clin. Biol. Res. *62*, 15-21.

MORI, K. (1981): Lysosomal enzyme in endotoxin shock. - Surg. Gynec. Obstet. *152*, 427-432.

NAYYAR, R.P., ZELLER, W.P., GOTO, M. and HURLEY, R.M. (1985): Endotoxin shock induced autophagy in liver, pancreas and kidney of neonatal rat. - J. Cell Biol. *101*, N.5. P.2.

NOVIKOFF, A.B., MORI, M., QUINTANA, N. and YAM, A. (1977): Studies of the secretory process in the mammalian exocrine pancreas. I. The condensing vacuoles. - J. Cell Biol. *75*, 148.

DE PALMA, R.G., COIL, J., DAVIS, J.H. and HOLDEN, W.D. (1967): Cellular and ultrastructural changes in endotoxaemia: a light and electronmicroscope study. - Surgery *62*, 505-515.

SEIFERT, G. (1970): Das Pancreas als Schockorgan. - In: HORATZ, K. (ed.): Leber und Pancreasschäden durch Scock und Narkose. Thieme, Stuttgart. pp. 17-30.

SUZUKI, T., MANABE, T. and HONJO, I. (1978): Role of the pancreas on organ blood flow during shock. - Surg. Gynec. Obstet. *146*, 557-582.

WEISMANN, G. and THOMAS, L. (1962): Studies on lysosomes. I. Effects on endotoxin, endotoxin tolerance and cortison release of acid hydrolases from granular fraction of rabbit liver. - J. Exper. Med. *116*, 433-450.

WEISSMANN, G. and THOMAS, L. (1964): On mechanism of tissue damage by bacterial endotoxin. - In: LAUDY, M. and BRAUN, W.: Bacterial Endotoxins: Procedings of a symposium held at the Inst. of Microbiology of Rutgers the State University. New Brunswick. pp. 602-609.

WEISSMANN, G.M.D. (1965): Lysosomes. - The New Engl. J. of Med. 1084-1090.

ACTA BIOL. SZEGED. 39. pp. 23-38. (1993)

NECROTIC EFFECTS OF THE XENOBIOTICS' ACCUMULATION IN THE CENTRAL NERVOUS SYSTEM OF A CRAYFISH (*ASTACUS LEPTODACTYLUS* ESCHZ.) *

J. SERFŐZŐ

Department of Comparative Animal Physiology, L. Kossuth University, H-4010 Debrecen, P.O.B. 3, Hungary

(Received: July 12, 1993.)

Abstract

The xenobiotics (Cd, Pb, Hg) accumulate in the central nervous system of the fresh water crayfish. As a result of the effects exercised by them, pathologic structural changes are induced in the cells of the cerebral ganglion - both anterior medial cells in the protocerebrum and olfactory lobe ones in the deutocerebrum - as well as glial cells surrounding the nerve cells. The pathologic changes show the characteristic signs of the hypoxia.

The maximum values of the xenobiotic accumulation develop irrespective of the seasons. On the basis of the mortality data, Cd proved to the most toxic elements from among the heavy metals examined.

Key words: xenobiotics, heavy metals, necrosis, hypoxia, nerve and glial cells

Introduction

Fresh water crayfishes discharge in the aquatic habitat "sanitary" services by living on weakened, ill and perished animals. They are very sensitive to toxic substances issuing from communal, industrial and agricultural sources being mostly responsive for the pollution of standing and running fresh waters. For this reason, the crayfish fauna in the polluted rivers and lakes becomes thinner and species one after the other disappear very often definitely from the habitat (JOHNSON and GENTILE, 1979; SERFŐZŐ et al., 1990a,b; SERFŐZŐ et al., 1992; VALLEE and ULMER, 1972).

Contradictory to the expectations, correlation between the survival or mortality rate of the animals and the quality of water characterized by chemical parameters (Hungarian Standard: MSZ-450.1.89.) in a given habitat could not be demonstrated (SERFŐZŐ et al., 1990a). Indeed, as regards the waters of Eastern Hungary, the mortality rate of crayfishes' populations under experimental conditions remained under 5% in the Ér channel of the branch system of the river Berettyó despite the supportable (IInd class) and often wrong (IIIrd class) water quality, while amounted

* This paper is dedicated to the centennial anniversary of Prof. AMBRUS ÁBRAHAM's birth.

somtimes to 80-100% in the mouth reach of the Keleti Főcsatorna (Eastern Main Channel) as well as in the lakes of Jusztus-Fekete meadow belonging to the Hortobágy National Park characterized mostly by good (Ist class) water quality. It may be supposed that in the background of this phenomenon, the unfavourable, pathobiological effects of accumulations of heavy metals must be searched for (SERFŐZŐ et al., 1992). Considering the discrepancy between the water quality and the mortality rate of crayfishes, we have studied the adaptational disposition in various habitats of a crayfish species being native of the Hungarian rivers. We paid atttention to follow the accumulation of Cd, Pb and Hg in the central nervous system, and examined their effects produced on the structure of the neurons with special regard to the pathological alterations taking place in them.

Material and Methods

Our investigations were carried out on a fresh water crayfish, *Astacus leptodactylus* ESCHZ. The test animals were moved from their natural habitat in the Ér channel being connected with the river Berettyó in Eastern Hungary to new environments choosen according as the reaches in question are exposed to polluting sources of communal, industrial or agricultural character. The lakes of Jusztus-Fekete meadow, a part of the Hortobágy National Park, was regarded as the standard for habitats because of having fresh water protected in theory from polluting effect of all kinds.

The test animals were placed in floating plastic cages, 20 to 25 for each one of the experiment stations. The putting into the new habitats was carried out in the first week of April, the samplings were effected in times depending on the water temperature: in spring and autumn at 12-16, in summer at 22-25 and in winter at 4-6 Celsius. The test material were males of 10-12 cm size.

Except the cerebral ganglion, the whole central nervous system was prepared for the analytical studies. The quantitative determination of the accumulated Cd, Pb and Hg was carried out with GFAAS (Grafite Furnace Atomic Absorption Spectrometry) methods. The cerebral ganglion served for cytopathological investigation. The structural damaging was studied on the anterior medial nerve cell group in the protocerebrum, and on the olfactory lobe nerve cell group in the deutocerebrum, respectively (ABBOTT, 1970, 1971; SANDEMAN, 1982).

The brain sheath was perforated befor the isolation with an injection syringe for then rinsing through the ganglion by a crayfish physiological salt solution (VAN HARREVELD, 1936). Thereupon s. collidine buffered 3% glutaraldehyde solution containing 3mM CaCl2, pH 7.4, was used for prefixing for 3hrs, at 4 Celsius. The samples washed overnight in 0.15 M s. collidine buffer, and postfixed in 1% osmium tetroxide solution buffered with s. collidine for 1 hr, at room temperature. The protocerebrum and deutocerebrum was embedded in Durcupan. The cuttings were made by LKB Ultratome III. Sections stained with uranyl acetate and lead citrate, and viewed in a Tesla BS 540 electron microscope.

For these examinations, the samples were used in which the accumulation of heavy metals showed remarkably high value. It may have been namely expected thet their damaging effects can be more consequently followed and analysed, respectively, in such cases.

Results

1. The increased xenobiotic accumulation in the central nervous system at the spring period of observation

On the sampling fields of the study, in 1987, prominently high accumulation values of xenobiotics in the central nervous system were found in the analysed samples of the spring period. Characterizing, however, the test animals alone taken from the observation posts established in the mouth reach of the Keleti Főcsatorna and in the lakes of the Jusztus-Fekete meadow belonging to the Hortobágy National Park. The quantity of the accumulated Cd, Pb and Hg amounted to 0.46-0.54, 2.04-4.93 and 4.65-6.39 ug/g referring to dry material, respectively, what is equivalent to concentration degrees of 153-180, 227-548 and 9300-12780-fold as compared to the limit values of the Ist class that is good-quality water. The stock of animals set out to this observation post perished almost enterily up to the time of the summer sampling, the mortality rate came to 93 and 100%, respectively.

The xenobiotic load leaves lasting marks on the anterior medial nerve cell group of protocerebrum. Swollen, rounded or collapsed, large-sized spaces develop from necrotized mitochondria and Golgi's vesicles in the cytoplasm, being surrounded by tightly linked glial cell processe. The endoplasmic reticulum becomes fragmented and disintegrated into small-sized vesicles. Pycnosis of the nucleus indicates its necrosis (Figs 1 and 2). Intact cell organelles are hardly or not et all to be found in the neurons.

Changes like those in the anterior medial nerve cells take place in the cytoplasm of the olfactory lobe nerve cells belonging to the deutocerebrum, too, with the difference, however, that nuclear pycnosis does not develop in them, while the structural changes caused by necroses in the cell organelles seem to be still more dramatic, because their relatively small cytoplasm is almost totally filled up by the swollen organelles (Fig. 3).

The pathologic structural changes in the neurons cover the axons, too. Local membrane hyperplasia and degeneration as well as the numerical decrease and agglutination, respectively, of the neurotubules may to be observed in the axons - surrounded by glial cell processe - of the anterior medial nerve cell group (Figs 4 and 5).

The glial cell processes, separating the neurons from one another while sticking to them, constitute loose layers. Lines of vesicles arranged like strings of pearls may be seen in the processes by filling up entirely their interior (Figs 4 and 5). Their continuity is broken here and there by the occurrence of residual bodies of various size. The membrane hyperplasia and degeneration observed in the necrotizing neurons appear repeatedly in the membranes of the processes of glial cells, too (Figs 2 and 4).

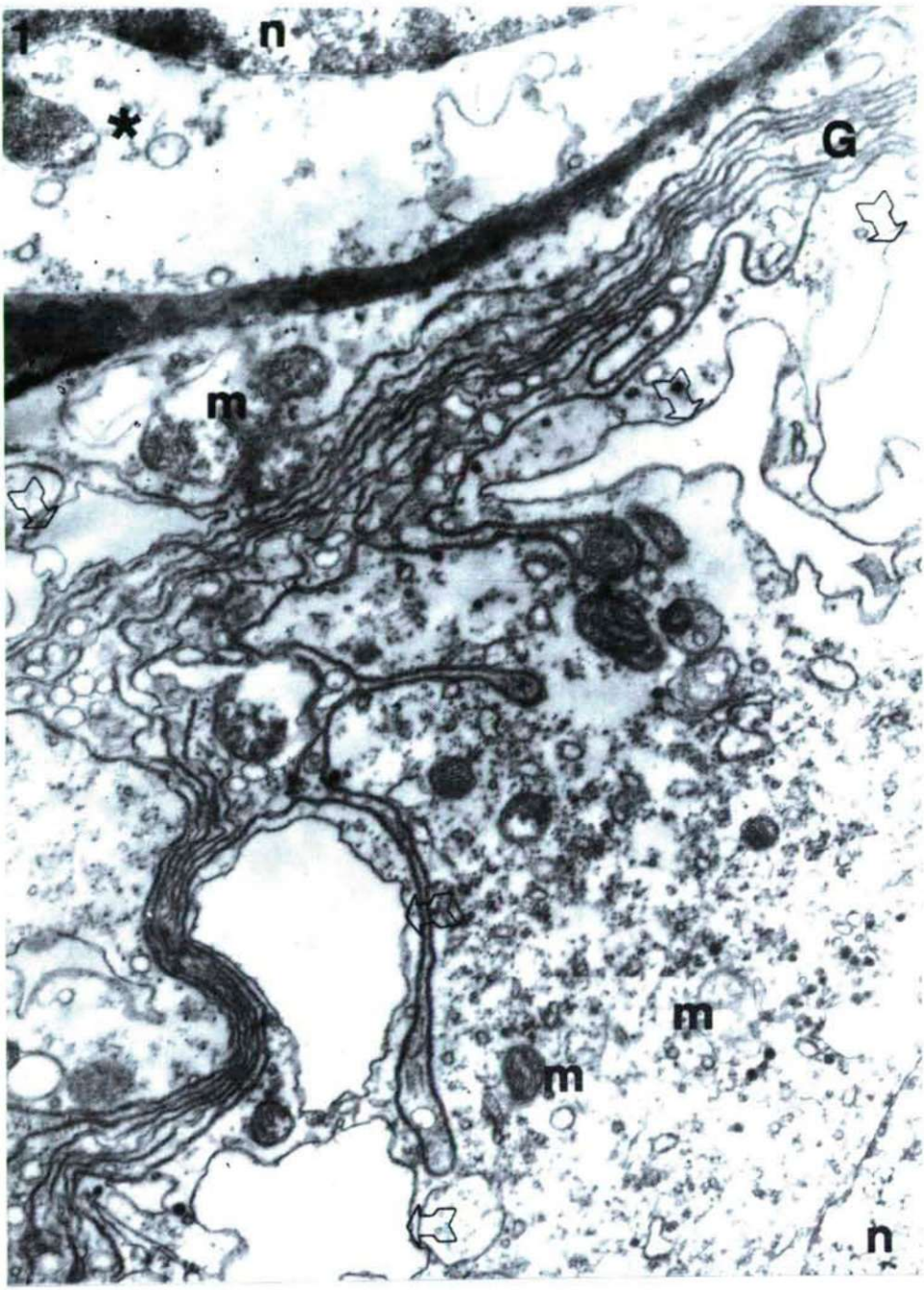


Fig. 1. Cell damaging with pycnotic nucleus (•), necrotized cytoplasm, and swollen and collapsed Golgi vesicles (white arrows) in the anterior medial nerve cell group. x21000. Abbreviations and Legends: a = axon; G = glial cell processes; ga = Golgi apparatus; m = mitochondrion; n = nucleus; rb = residual body.

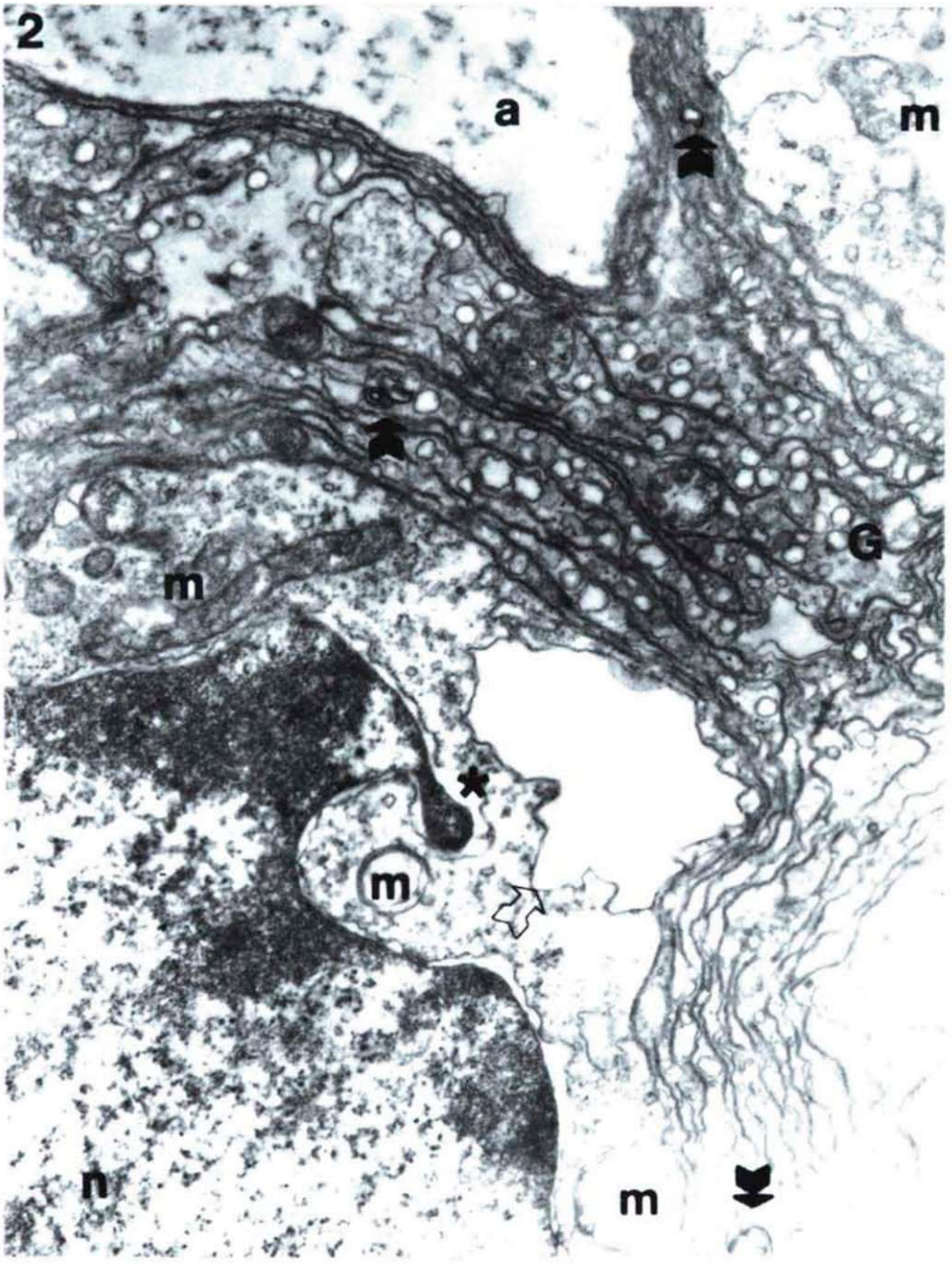


Fig. 2. Increased development of vesicles and local membrane damaging (black arrows) in the glial cell processes. There is pycnotic nucleus (*) and polygonal Golgi vesicle in the anterior medial nerve cell (white arrow). x21000

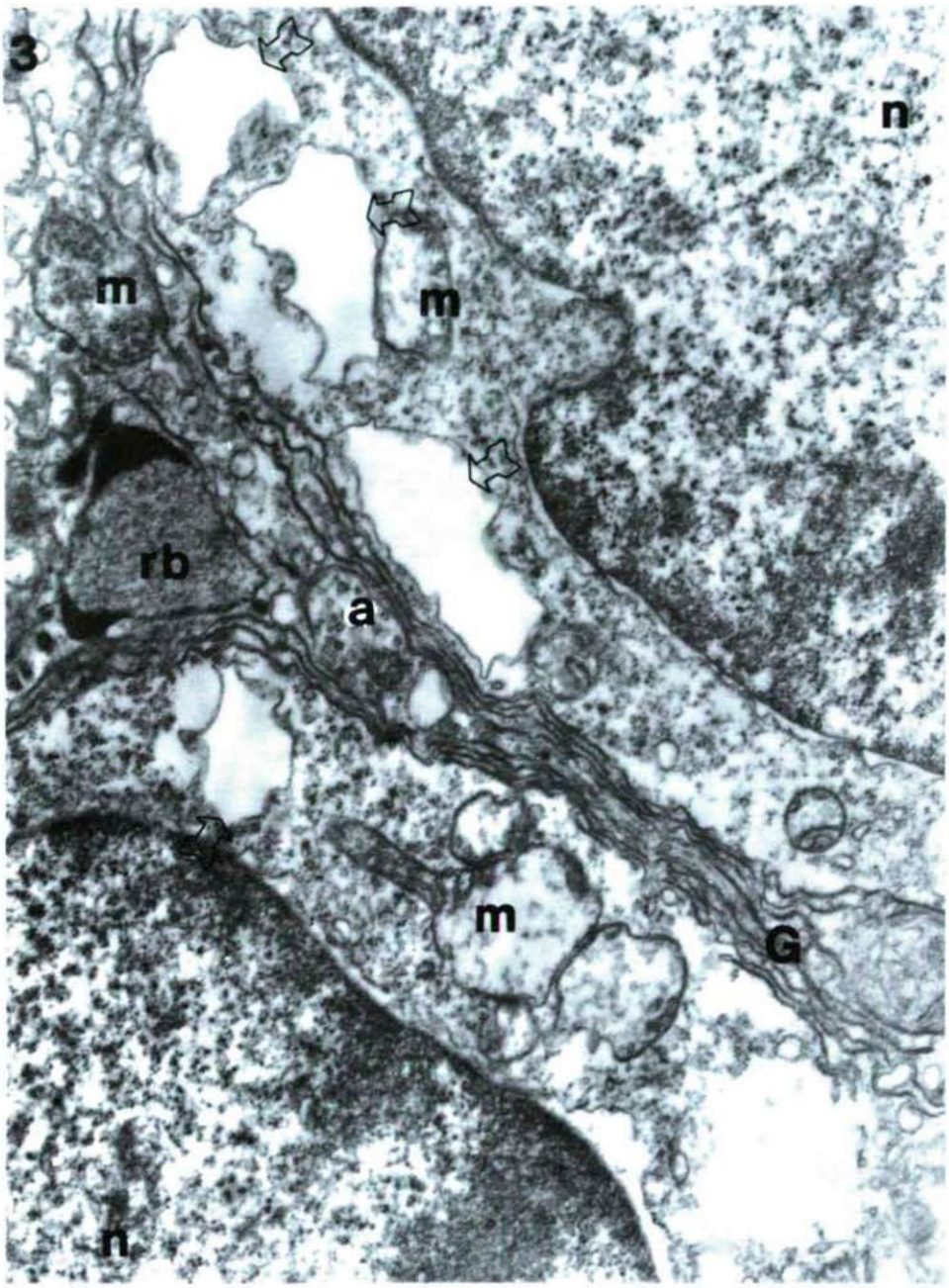


Fig. 3. Swollen and polygonal Golgi vesicles in the deutocerebral olfactory lobe neurons. (White arrows) x21000

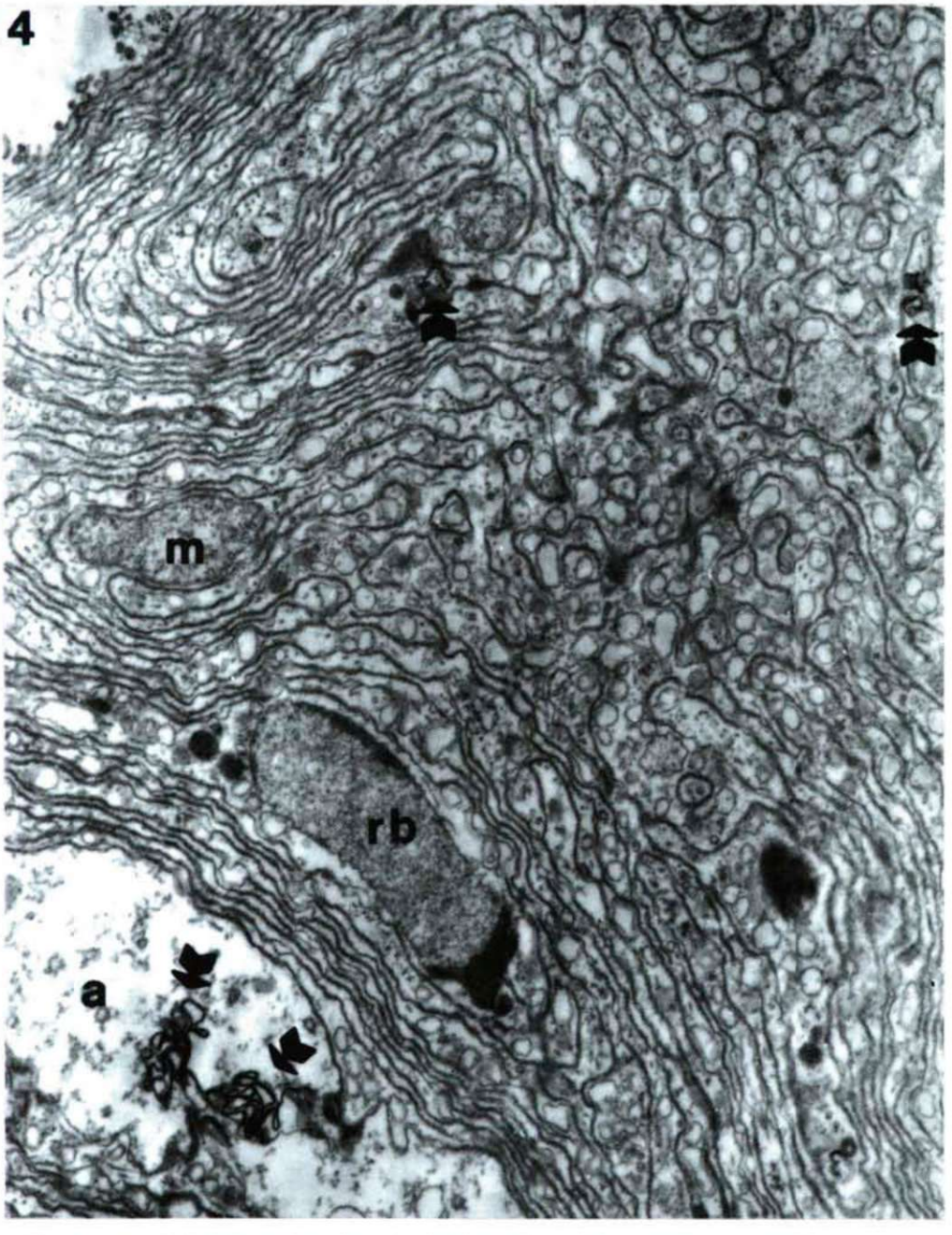


Fig. 4. Axon and glial cell membrane damaging in the anterior mediel nerve cell cell group. (Black arrows) x21000

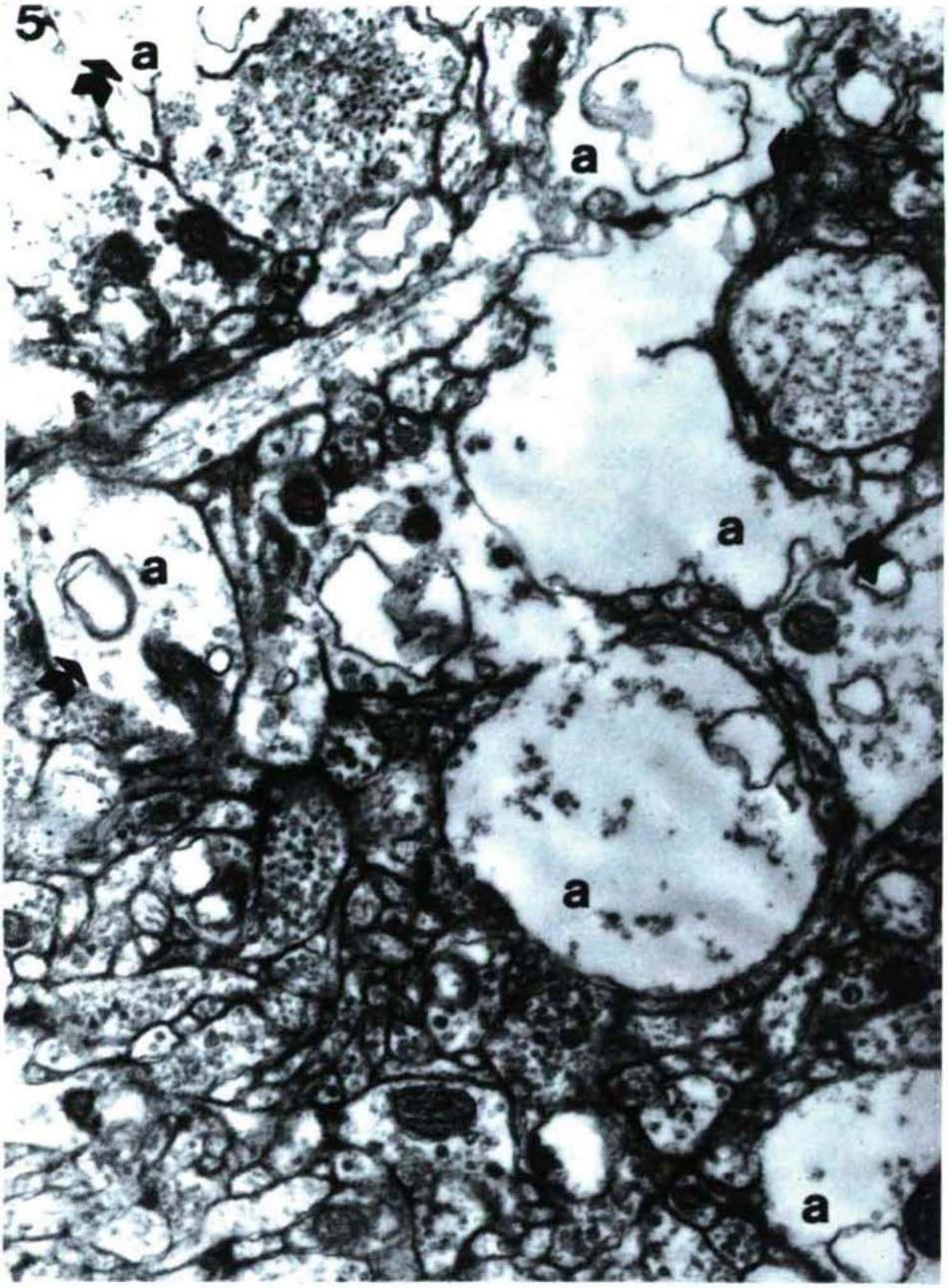


Fig. 5. Axon damaging between the area of anterior medial and olfactory lobe nerve cell group. (Black arrows) x24000

2. The increased xenobiotic accumulation in the central nervous system during the summer period of the observation

Among the samples examined in the summer period of 1988, we found cases showing prominently high values of xenobiotic accumulation. The samples in question set in the river Berettyó. The quantity of Cd, Pb and Hg was found to be 0.08, 8.07 and 1.4 ug/g referring to dry material, respectively, what means enrichment to 27, 897 and 2800-fold as much as compared to the limit of the Ist class that is good-quality water. The mortality rate in the sampling period, with the given xenobiotic load, came to 41%.

The structure of the anterior medial nerve cell group of the protocerebrum was influenced by the accumulated elements efficiently in thise cases, too. The damaging effect, however, was not so generally extended on all neurons and so drastic as in the spring period's samples examined in 1987. The most apparent pathologic alterations develop in the mitocondria: disorganized internal membrane and swollen organelle. The Golgi's vesicles are characterized by oedema, after having swollen they collapse (Fig. 6). It comes to fragmentation of the endoplasmic reticulum, to nuclear pycnoses, however, it dosn't. The permanent presence of mitochondrial and Golgi's swollen vesicles occupying large spaces in the cytoplasm points, however, that phenomena remaining not local and being able to induce extended erosions may take place at any time in the intracellular spaces.

The influence of the given xenobiotic load on the structure of the olfactory lobe neuron group in the deutocerebrum proved to be slight, the cell organelles are not damaged in a remarkable degree. Oedematous status did not develop, and the incidence rate of axon degeneration is negligible, too. (Fig. 7.)

The xenobiotic accumulation had no slightly appearing effect damaging glial cells in either of the two neuron groups. In the glial cell processes of the samples investigated, it came neither to an increased forming of vesicles, nor to the development of oedema and to the loosening of the processes. The linking between glia and nerve remained normal.

3. The increased xenobiotic accumulation in the nervous system at the autumnal term of the experiments

On the observational posts placed in the river Berettyó, increased xenobiotic accumulation in the central nervous system of the test animals was found not only in the summer but also in the autumnal period of 1988. The quantity of Cd, Pb and Hg was 0.028, 5.3 and 1.4 ug/g referring to the dry material, respectively, what means concentration of 9, 589 and 2800-fold as compared to the limit of the Ist class that is good-quality water. At the term of the sampling, the animals were healthy, none of them perished.

Excepting nuclear pycnosis, all the structural changes previously described may have been observed in the anterior medial nerve cells group of the protocerebrum (Fig. 8), that is mitochondrial degeneration, development of large-sized, oedematous

vesicles, fragmentation of the endoplasmic reticulum in the cytoplasm. However, the damaging effects on the mentioned cell organelles do not reach the critical measure that would result in the death of the nerve cells.

In the cell group of the deutocerebral olfactory lobe, signs of nuclear necrosis may not be observed. If it still occured, did not rise above the measure being in accordance with a hypertrophic activity under otherwise normal circumstances (Fig. 9).

The glial cell processes surrounding the nerve cells are regular. Vesicles may be found in them but sporadically, oedema does not develop at all. Their structure indicates the normal state for as much as their linking up to the nerve cells is free from pathologic alterations, e.g. from hyperplasic membrane areas, too.

Discussion

Having analysed the water quality of fresh waters in Eastern Hungary, the river Berettyó and its branch system, the lakes of Jusztus-Fekete meadow in the Hortobágy National Park, we found not a single parameter used to qualification of waters, e.g. oxigen, ammonia, pH, temparature, detergents, oils, etc, the acute and chronic change of which would have furnished informations about the rate, place and time of mortality of the crayfish (SERFŐZŐ et al., 1990 a,b). The discrepancy appearing between the changes in the quality of water and the mortality rate of the experimental animals may be resolved, according to our investigations, with knowledge of the accumulation of xenobiotics in the organism of the animals. We have established that the Cd already in a concentration of 100 ng/g increases markedly the mortality rate, and by or over a loading of 300 ng/g, respectively, induce the almost entire perishing of the stock of animal placed in the experimental stations (SERFŐZŐ et al., 1991).

From the present examinations, it is evident that the efficiency of Cd is not or not strikingly, respectively, increased by the accumulation of Pb and Hg. The Cd and Hg contents of the samples of the summer and autumnal terms are small as compared to that in the spring samples. It seems to be characteristic that despite the hihg Pb content in the summer and autumnal samples, the rate of survival becomes better, that is the mortality rate decreases.

The maximum values of the xenobiotics' accumulations may not be connected with one of terms in the year influencing the vital processe of the animals (SERFŐZŐ, 1990c). These namely, may have been observed anywhere on the field of sampling and at any term. Consequently, the phenomenon may not be attributed mainly to causes arising from the feed but to changes taking place in the aquatic habitat. A former observation, the increase of Mn content of the central nervous system retardes the damaging effects of Cd, Pb and Hg, points to this, too (SERFŐZŐ et al., 1990b).

The xenobiotics influence damaging the structure of nerve cell groups of the cerebral ganglion. This appears most strikingly in the necrosis of the interior membrane of the mitochondria. Moreover, it comes to development of abnormal

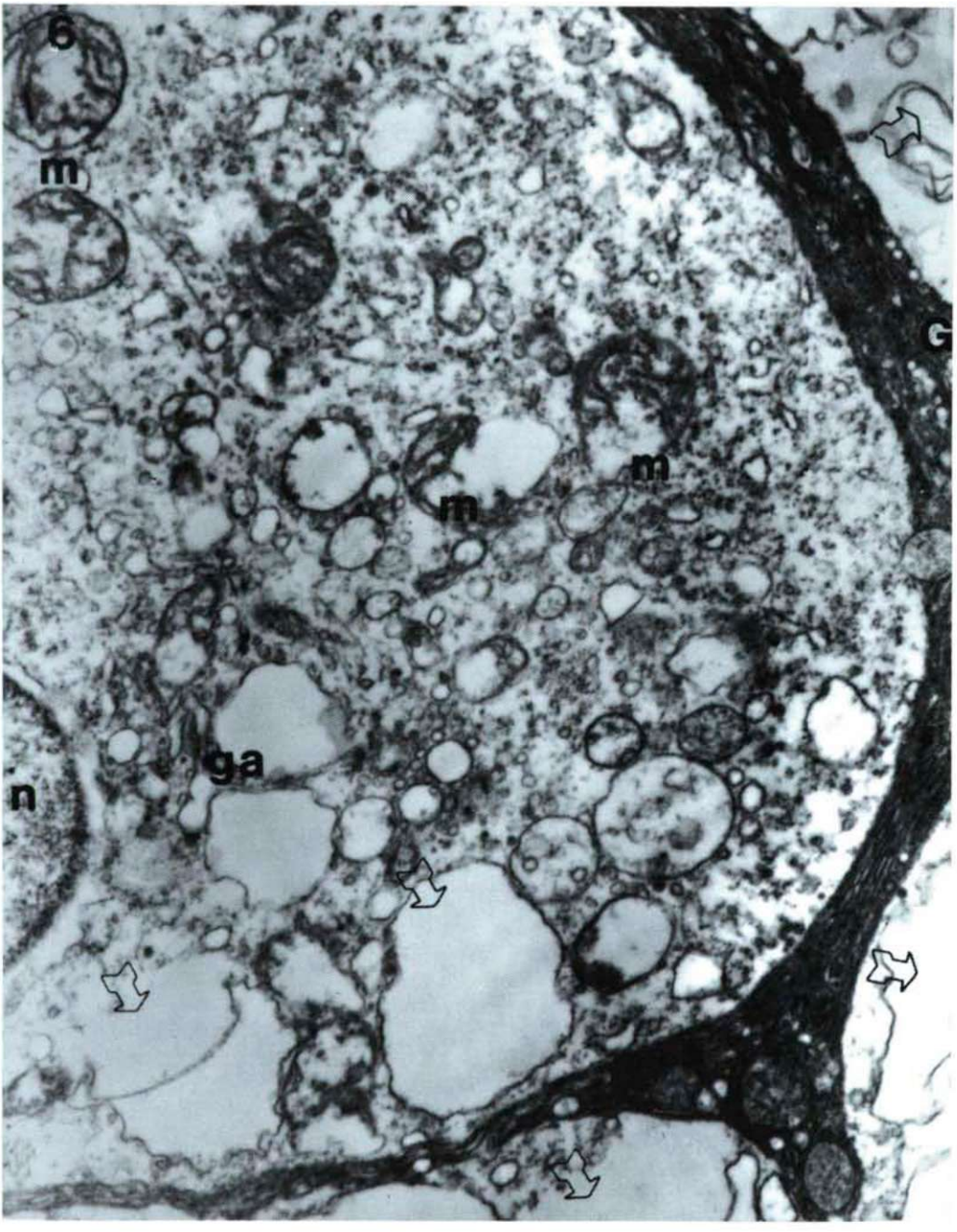


Fig. 6. Slighty damaging nerve cell of the anterior medial nerve group with swollen and collapsed Golgi vesicles. (White arrows) x21000

Fig. 7. Mitochondria damaging and formation of myelin bodies in the olfactory lobe nerve cell group. (Black arrows). x21000

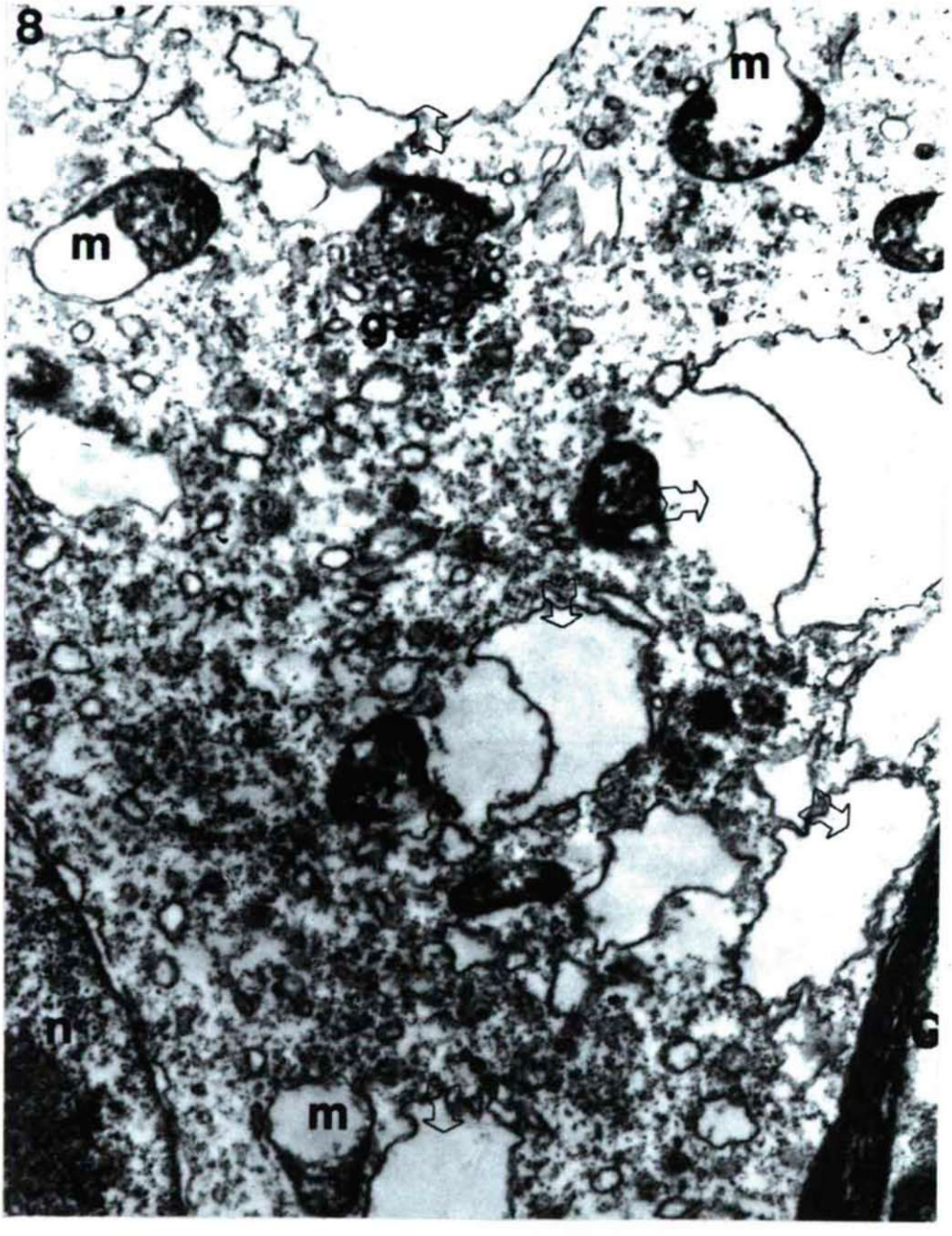


Fig. 8. Increased formation of swollen and polygonal Golgi vesicles in the anterior medial nerve cell. (White arrows) x21000

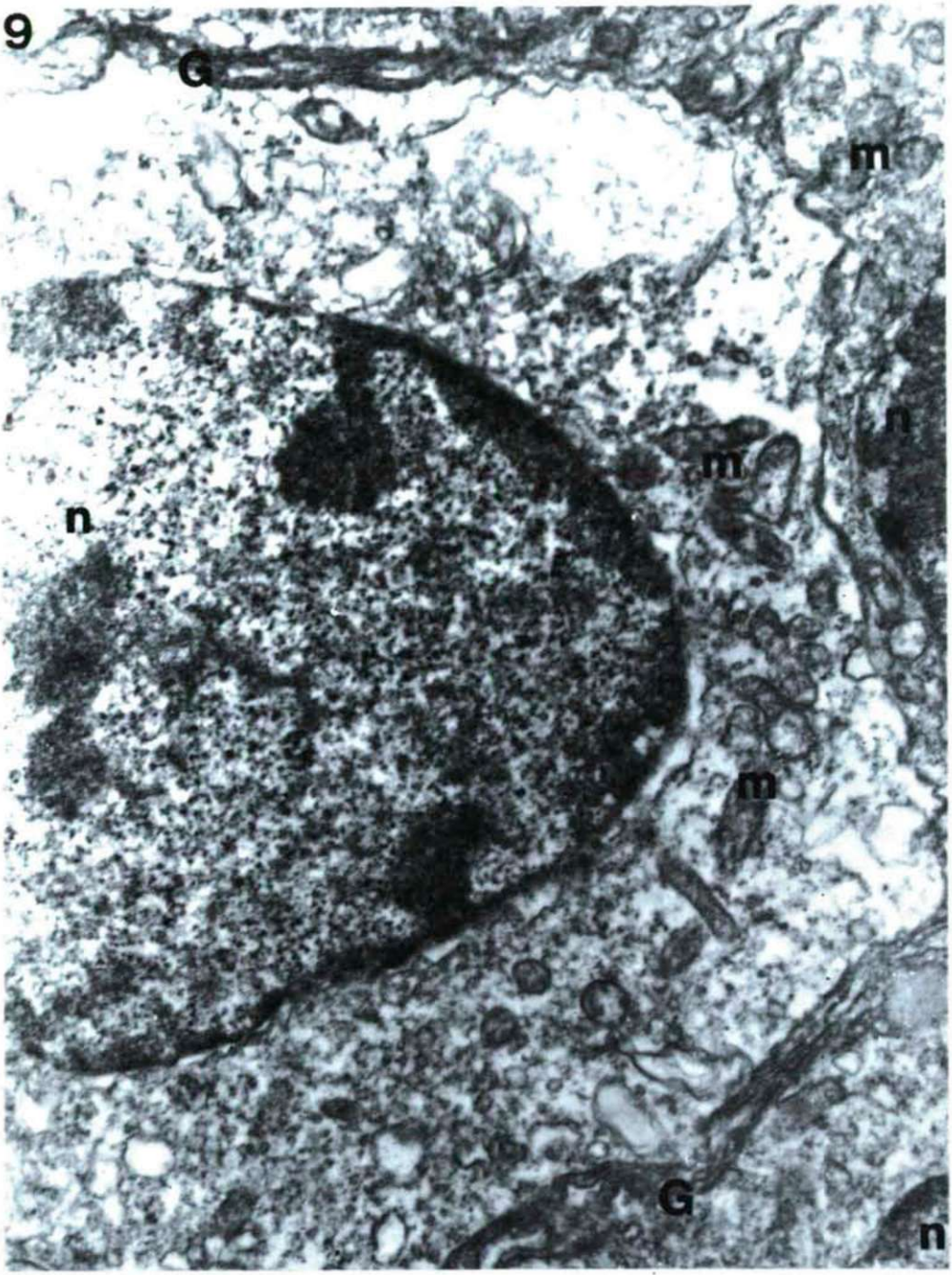


Fig. 9. Slightly hypertrophysed nerve cell in the olfactory nerve cell group. x21000

Golgi's vesicles, fragmentation of endoplasmic reticulum and nuclear pycnosis, too. Membrane degenerations appear mainly in the axons. During the pathologic processes, the cell organelles are swollen, but among the Golgi's vesicles, collapsed, polygonal forms are to be observed, too. The syndrome described points to hypoxia (CONSTATINIDES, 1984; GOYER, 1991). Considering, however, that in the nerve cell groups examined, not all the cells show strikingly marked structural damages, we have to suppose that either also other factors may have a share in the process or the susceptibility of the damaged nerve cells is the source of the difference. The xenobiotic accumulation does not allow to remain intact the structure of the glial cell processes surrounding the nerve cells, too. The processes fill with vesicles, become swollen, degenerated areas are to be found in their membranes. There is a close relationship between the state of the glial cell processes and the pathologic changes appearing in the nerve cells. In all the cases when the glial cell loosens the linking between glia and nerve, this happens during the increased formation and swelling of vesicles, the consequences of the xenobiotic accumulation appear in the nerve cells more strikingly, and conversely. (SERFŐZŐ et al., 1991; SERFŐZŐ et al., 1992).

Summary

The central nervous system of the crayfish is able to accumulate xenobiotics in considerable quantities. In the manmade habitats set up in the rivers and lakes of Eastern Hungary. The concentration degree of Cd, Pb and Hg was 9-180, 227-897 and 2800-1278-fold, respectively, as compared to the limit values characteristic of the Ist class that is good-quality water. The maximum values of the accumulation developped irrespective of the seasons. It might not be drawn a parallel between the fact of accumulation and a vital functions of the animals. On the basis of the mortality data, Cd proved to be the most toxic from the heavy metals examined.

As a result of the xenobiotics' accumulation, the fine structure of the nerve cells has to be suffer changes. These include almost every cell organelles by inducing nuclear pycnosis, mitocondrial disorganisation, abnormal development and collapse of Golgi's vesicles, fragmentation of endoplasmic reticulum and alterations in the membrane of the axons.

Changes take place in the glial cell processes, too: increased development of vesicles including almost the whole system of the processes, emergence of residual bodies and membrane degenerations.

The degenerative alterations taking place in the fine structure of both the nerve and glial cells may be brought in overlapping with the degree of the xenobiotic accumulation. The symptomes are typic manifestational forms of the hypoxia.

References

ABBOTT, N. J. (1970): Absence of blood-brain barrier in a crustacean, *Carcinus maeneas* (L). - Nature *225*, 291-293.

ABBOTT, N. J. (1971): The organization of the cerebral ganglion in the shore crab, *Carcinus maeneas* (L). II. The relation of intercerebral blood vessels to other brain elements. - Z. Zellforsch. Mikrosk. Anat. *120*, 401-420.

CONSTANTINIDES, P. (1984): Ultrastructural Pathobiology. - Elsevier Science Publishers B. V., Amsterdam - New York - Oxford. pp. 279-317.

GOYER, R. A. (1991): Toxic effects of metals. - In: AMDUR, M. O., DOULL, J. and KLAASEN, C. D. (eds.): Toxicology. The Basic Science of Poisons. 4th Edition. Pergamon Press. New York. pp. 623-680.

JOHNSON, M.W. and GENTILE, J. H. (1979): Acute toxicity of cadmium, copper and mercury to larval american lobster, *Homarus americanus*. - Bull. Environ. Contam. Toxicol. *22*, 258-265.

SANDEMAN, D. C. (1982): Organizationof the central nervous system. - In: BLISS, D. E. (ed. in chief): The Biology of Crustacea. Vol. III. Neurobiology: Structure and Function (eds.: ATWOOD, H. L. and SANDEMAN, D. C.). Academic Press, New York. pp. 1-61.

SERFŐZŐ, J., PÁDÁR, I., ARADI, CS., B. KISS, ZS., POSTA, J. and SZŰCS, L. (1990a): Applicability of classic water qualificatory data on the judgemenet of habitat and on the development and interpretation of stress in a model experiment with a crayfish, *Astacus leptodactylus* ESCHZ. - 19th Cong. Hung. Biol. Soc., Nyíregyháza, 23-25 August. pp. 69-70.

SERFŐZŐ, J., PÁDÁR, I., ARADI, CS., B. KISS, ZS., POSTA, J. and SZŰCS, L. (1990b): Changes of adaptation and survive of a crayfish, *Astacus leptodactylus* ESCHZ., in Hungarian lakes and rivers by the reason of accumulation model experiments with xenobiotics. - 19th Cong. Hung. Biol. Soc., Nyíregyháza, 23-25 August. pp. 71-72.

SERFŐZŐ, J., POSTA, J., SZŰCS, L., PÁDÁR, I., ARADI, CS. and B. KISS, ZS. (1990c): Seasonal changes of xenobiotic accumulation in the central nervous system of a crayfish, *Astacus leptodactylus* ESCHZ. - 55th Cong. Hung. Physiol. Soc., Budapest, 4-6 July. p. 170. (In Hungarian)

SERFŐZŐ, J., B. KISS, ZS., PÁDÁR, I., ARADI, CS., POSTA, J. and SZŰCS, L. (1991): Effects of xenobiotic accumulation on the central nervous system of a crayfish. - 56th Cong. Hung. Physiol. Soc., Szeged, 27-30 August. p.193. (In Hungarian)

SERFŐZŐ, J., B. KISS, ZS., PÁDÁR, I., ARADI, CS., POSTA, J. and SZŰCS, L. (1992): Consequences of Cd accumulation in the central nervous system of a fresh water crayfish, *Astacus leptodactylus* ESCHZ. - 20th Cong. Hung. Biol. Soc., Kecskemét, 26-28 August. p. 58.

VALLEE, B. L. and ULMER, D. D. (1972): Biochemical effects of mercury, cadmium and lead. - Ann. Rev. Biochem. *41*, 91-114.

VAN HARREVELD, A. (1936): A physiological salt solution for the fresh-water crustaceans. Proc. Soc. Exp. Biol. Med. *34*, 428-432.

ACTA BIOL. SZEGED. 39. pp. 39-49. (1993)

SEROTONIN CONTENT DURING THE REGENERATION OF NERVOUS SYSTEM IN EARTHWORM (*LUMBRICUS TERRESTRIS* L., OLIGOCHAETA) *

M. CSOKNYA[+], I. LENGVÁRI[++], L. HIRIPI[+++], K. ELEKES[+++], J. VINCZE[+], M. SZELIER[++] and J. HÁMORI[+]

+Department of Zoology, Janus Pannonius University, Pécs, H-7604

++Department of Anatomy, University Medical School, Pécs, H-7643

+++Department of Experimental Zoology, Balaton Limnological Research Institute, Hungarian Academy of Science, Tihany, H-8237, Hungary

(Received: June 15, 1993)

Abstract

Serotoninergic nerve cells were found in both the cerebral as well as the segmental ganglia of the earthworm (*Lumbricus terrestris* L.) by immunohistochemistry, and a high level of the amine by HPLC. Comparing the intact ganglia to that of the regenerating nervous system it was found that

1. in the regenerating tissue at first serotoninergic fibers, later serotoninergic cells were detected by immunostaining;

2. during the first 3 days of the regeneration the level of serotonin is highly decreased in the all intact ganglia;

3. after day 3 the content of serotonin gradually increases and maximal level is reached by day 17;

According to our data it seems probable that there are some interrelationships between the regeneration process and the serotonin content of both the intact and regenerating nervous tissue.

Key words: nervous system, regeneration, serotonin, immunohistochemistry, serotonin assay, earthworm

Introduction

The regeneration of the central nervous system in the earthworm has been studied by many authors (CHAPRON, 1970; HERLANT-MEEWIS, 1962, 1964; ZHINKIN, 1936).

If the ventral cord of an intact earthworm is transected, or if pieces of the nerve cord are removed, or the cerebral ganglia is extirpated (without removing the head) complete morphological as well as functional regeneration takes place. FRIEDLÄNDER

* This paper is dedicated to the centennial anniversary of Prof. AMBRUS ÁBRAHÁM's birth.

(1888) regarded the regenerated ganglia as derived mainly from the remaining nervous tissue, and perhaps partly from the regeneration tissue. It is supposed, that the new nerve cells originated from small indifferent cells which retained their embryonic character in the ganglia. CORNEC et al. (1987) hypothesized that the migration of these cells is limited. In this regard, it is interesting to relate the regenerative of process of earthworm to the information we have about regeneration of nervous system in vertebrates. Migrating chicken neural crest cells were seen to accumulate and according to their location, to from organs including spinal ganglia, medulla-suprarenal glands (THIERY et al., 1977).

Since SCHARRER (1937) first described neurosecretory cells in the central nervous system of the earthworm, many investigators have studied neurosecretion of these animals. It has been suggested that some types of neurosecretory cells in the cerebral ganglion are involved in the growth and regeneration of the nervous system. Numerous questions are arise concerning the mechanisms by which molecules participate in the growing or regenerating process of the nervous system (BERG, 1984; JESSEL, 1988).

Information on the distribution and function of neuroactive compounds in the nervous system of annelids are still limited. The occurence of some neuroactive materials (serotonin, dopamine, noradrenalin, octopamine) has been established in the ventral cord of the earthworm (LENGVÁRI et al., 1992; MYHRBERG, 1967; 1972; RUDE, 1966; SPÖRHASE-EICHMANN et al., 1987a; 1987b).

Additional studies (KORITSÁNSZKY and HARTWIG, 1974; STEPHAN-DUBOIS, 1956; WELSH and MOORHEAD, 1960) dealt with he distribution and production of monoaminergic cells. The aim of the present investigation was to clarify the possible role of monoamine serotonin in the regeneration process of the nervous tissue in Annelids.

Material and methods

Adult specimens of earthworms (*Lumbricus terrestris* L., *Oligochaeta*) were collected locally (April and May) and were kept at 4 °C in moistened soil supplemented with leaves until required. The animals were sacrified either by decapitation or by anesthesia in carbonic acid solution. The ganglia were dissected out for immunohistology, electron microscopy as well as chromatography.

For immunohistological purposes 3-5 mm long pieces of whole animals were embedded into paraffin after fixation in ZAMBONI'S fixative (ZAMBONI and DE MARTINO, 1967) and 10 µm thick serial sections were cut. The sections were immunostained according to the method of STERNBERGER (STERNBERGER et al., 1970) utilizing serotonin primary antiserum developed in rabbit (1:4000; GÖRCS et al., 1985). Sheep anti-rabbit-gammaglobulin (1:300) and rabbit peroxidase-antiperoxidase complex (1:600) were obtained from Arnel.

For electron microscopic studies the ganglia were prefixed in KARNOVSKY'S fixative (1965) at 4 °C for 2 h followed by fixation in 2% osmiumtetroxide and they were embedded in Durcupan (Fluka). The materials were post-stained in blocks with uranil-acetate and on sections with lead-nitrate (REYNOLDS, 1963). The sections were examined under JEOL 100B electron microscope.

Serotonin assay: earthworms were narcotized as above and isolated ganglia were dissected out. The frozen samples were homogenized ice-cold in 200 µl 0.1 n $HClO_4$ containing isoproterenol as internal

standard. The homogenate were centrifuged at 10,000xg for 20 min. at 4 °C. Aliquot of the supernatant was transferred into the LCEC with a Wisp automatic injector (Waters). Tissue serotonin content was measured using a reverse-phase chromatography procedure coupled with an electrochemical detection. The LCEC system consisted of a solvent delivery system (Waters 510), electrochemical detector (Waters 460) and 745B integrator (Waters). The column, Nucleosil C18 5 μm (Macherey Nagel) were kept at 40 °C. The flow rate was 1 ml/min. The mobil phase consisted of 0.1 M sodium phosphate buffer pH 1.1 mM octane sulfonic acid, 10% methanol.

Results and discussion

A detailed description of the distribution of the monoamines in central and peripheral nervous system of *Lumbricus terrestris* has previously been given by EHINGER et al. (1971), LENGVÁRI et al. (1992), MYHRBERG (1967), RUDE (1966), SPÖRHASE-EICHMANN (1987a; b). Serotonin immunoreactive cell bodies as well as fibers occur in all parts of the central nervous system. In the present study, we determined the distribution of serotoninerg neurons of the ganglia relative to their position to the clitellum, as well as that of sub- and supraesophageal ganglia. The ganglia situated anterior to clitellum have been regarded as "typical" ganglia of the central nervous system in earthworm (GÜNTHER, 1971 a, b).

The subesophageal ganglion and the ganglia of the ventral cord contain numerous serotoninergic cells. There is a gradual decrease in the number of serotonin cell bodies relative to the position of ganglia, i.e. the more posterior the ganglon is the less serotoninergic cells are found. There are two distinct cell groups in a "typical" ganglion (Table I, Figs. 1, 2). The perikarya of these cells can be characterized by their shape and location. One cell group is situated in ventro-medial position bilaterally (Table I, Figs 1, 2). They are large cells which send their axons into the neuropil, both uni- and bilaterally. Occasionally these processes can be traced into the origin of the segmental nerves. Another cell group is located more laterally, at the level of 2nd and 3rd segmental nerves (Table I, Fig. 3). These neurons are smaller, and their processes are mostly distributed unilaterally and referred as intermediate cells. It is very important to emphasis that serotoninergic fibers of a "typical ganglion" occupy the entire neuropil offering an easily detectable framework in the ganglion. This makes serotonin immunostaining a very useful tool studying the regeneration process.

In the cerebral ganglion, the serotonin immunopositive cells are situated in two groups (Table I, Fig. 4, Table II, Fig. 1). One group is found in the dorsal part of the ganglion and the perikarya look like those which are considered neurosecretory cells according to the classical description. Another serotoninergic cell group is located more laterally (Table II, Fig. 2), close to the junction between the ganglion and the circumpharyngeal commissure. Additional serotonin positive cells are in the stomatogastric ganglia. The connectives contain large number of serotoninergic fibers. Ultrastructurally the serotoninergic neurons are large, unipolar and pyriform in

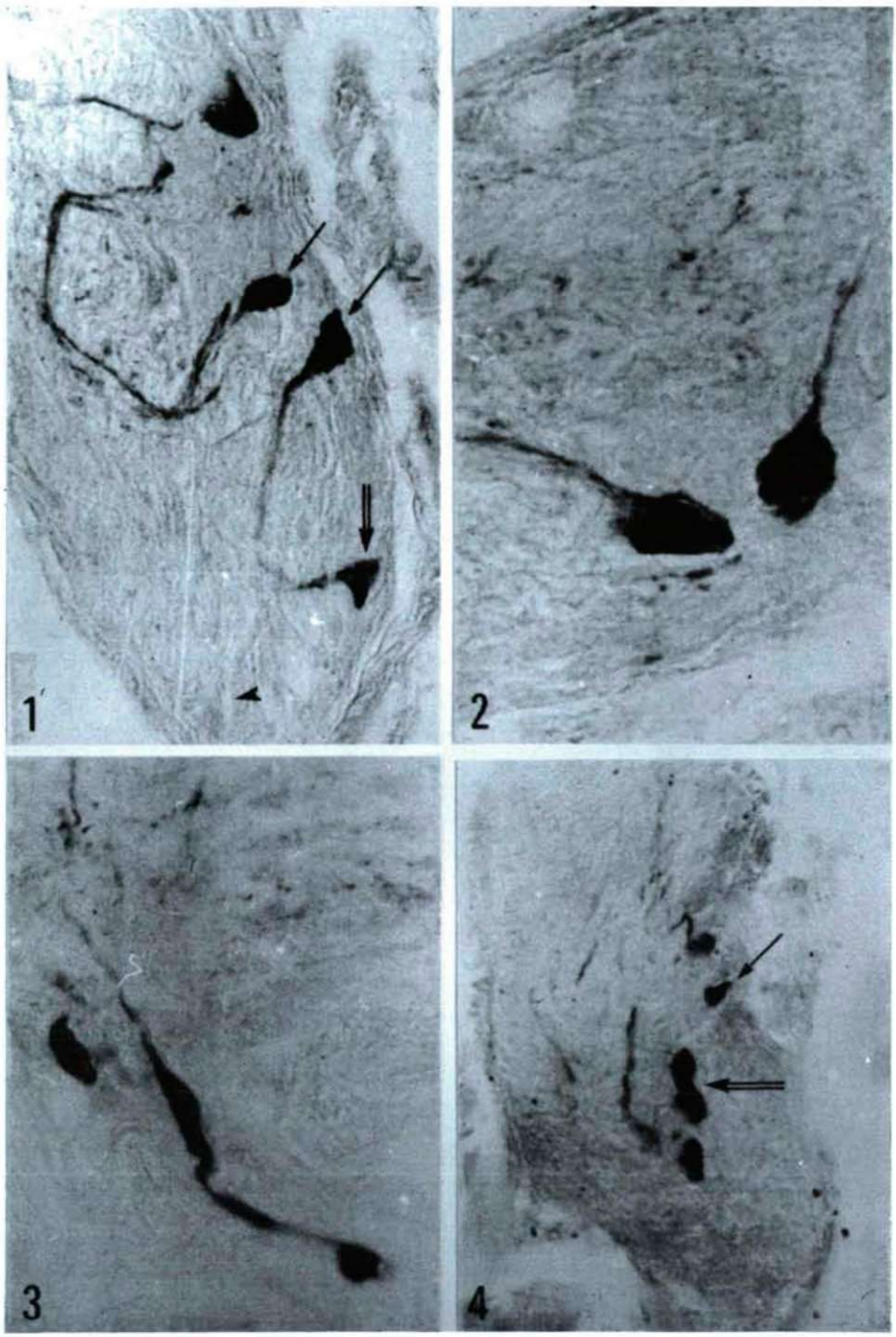
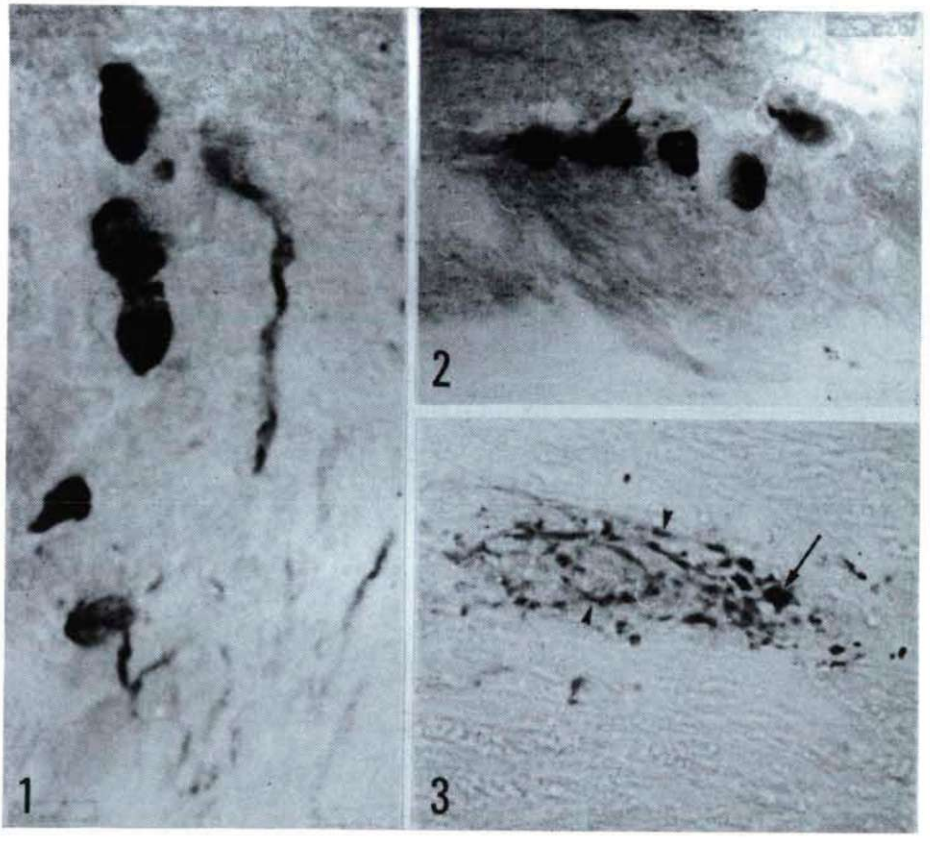

1
2
3
4

Table II. Fig. 1. Dorsally located serotoninerg perikarya of the cerebral ganglion. 900x

Fig. 2. Lateral serotoninergic cells of the cerebral ganglion. 450x

Fig. 3. Regenerated cerebral ganglion with serotoninergic cells (arrows) and fibers (arrowheads). 450x

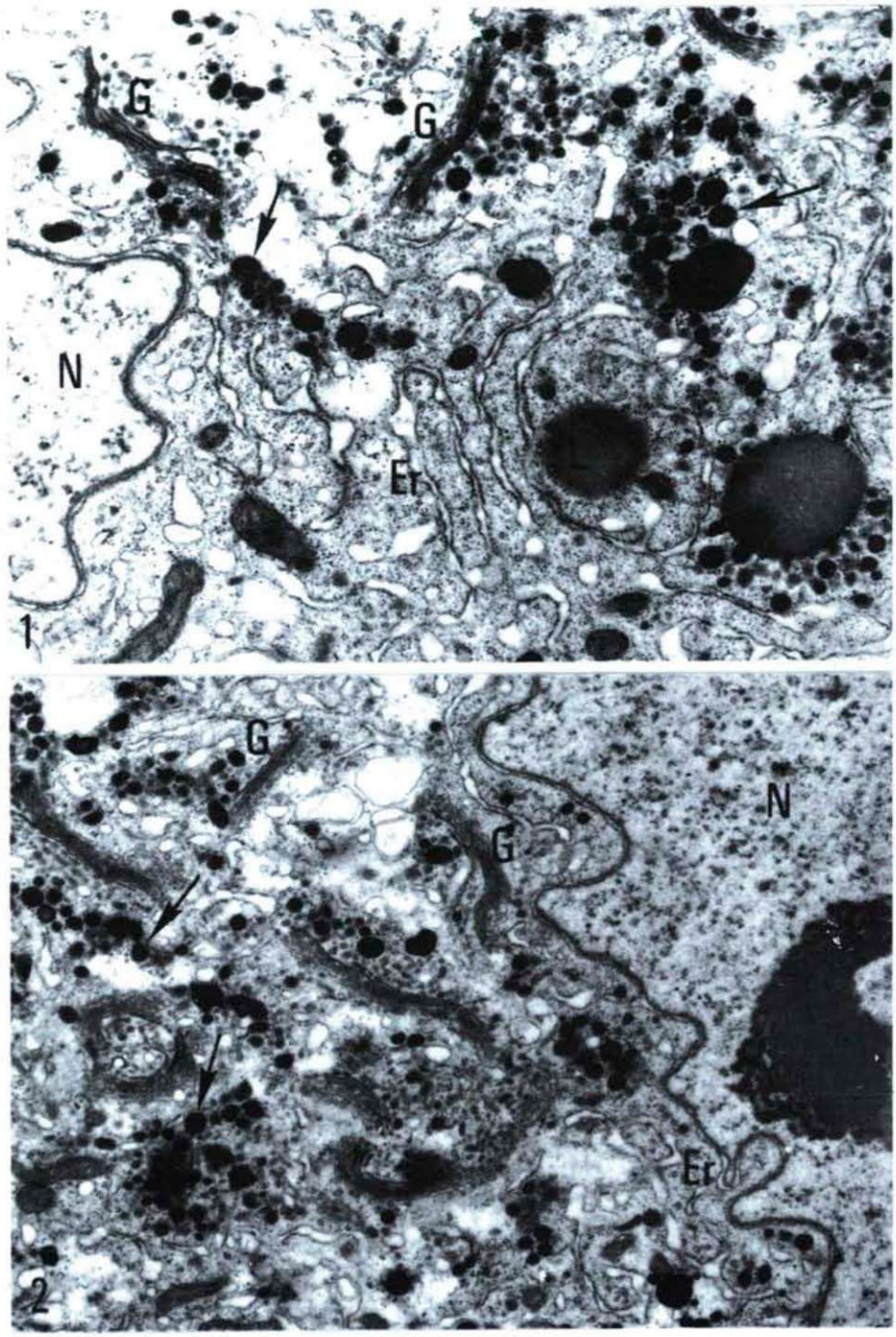


⇦ Table I. Fig. 1. Transverse section of a segmental ganglion. Note the large medioventral (arrows) and lateral (double arrow) serotoninergic cells, as well as nonreactive lateral cells (arrowheads) and serotoninergic fibers in the neuropil. 300x

Fig. 2. Medioventral serotoninergic cells with ipsilaterally projecting axons. 600x

Fig. 3. Serotoninergic cell close to the origin of 2nd and 3rd segmental nerves. 850x

Fig. 4. Horizontal section of the subesophageal ganglion showing medial (arrow) and lateral (double arrow) serotoninergic perikarya, as well as serotoninergic fibers. 300x


G
G
N
Er
1
G
G
N
Er
2

their shape. They have a large clear nucleus often with an irregular outline. The nucleus lies eccentrically, apposite to the axon hillock. The granular endoplasmic reticulum is mostly found in the perinuclear zone (Table III, Fig. 1). The mithocondria are scattered throughout the cytoplasm randomly. Golgi-complex and many granules and vesicles are grouped in the periphery of the cell near the axon hillock. The granules are spherical. In addition, there are large round lipid globules, either as single units or as aggregates. A characteristic feature of the intermediate cells is that their contain both dense vesicles, as well as dense granules (Table III, Fig. 2). Serotonin immunopositive cells of the cerebral ganglion are similar ultrastructurally (Table IV, Figs. 1, 2).

Earlier fluorescence microscopy studies have shown serotonin and primary catecholamines in polychaetes (ANCTIL et al., 1990; BIANCHI et al., 1988; CLARK, 1966). These substances have also been demonstrated in the leech both histochemically and with microspectrofluorometry (EHINGER et al., 1968, 1971; RUDE et al., 1969). Our earlier (LENGVÁRI et al., 1992) and present results confirm these previous findings.

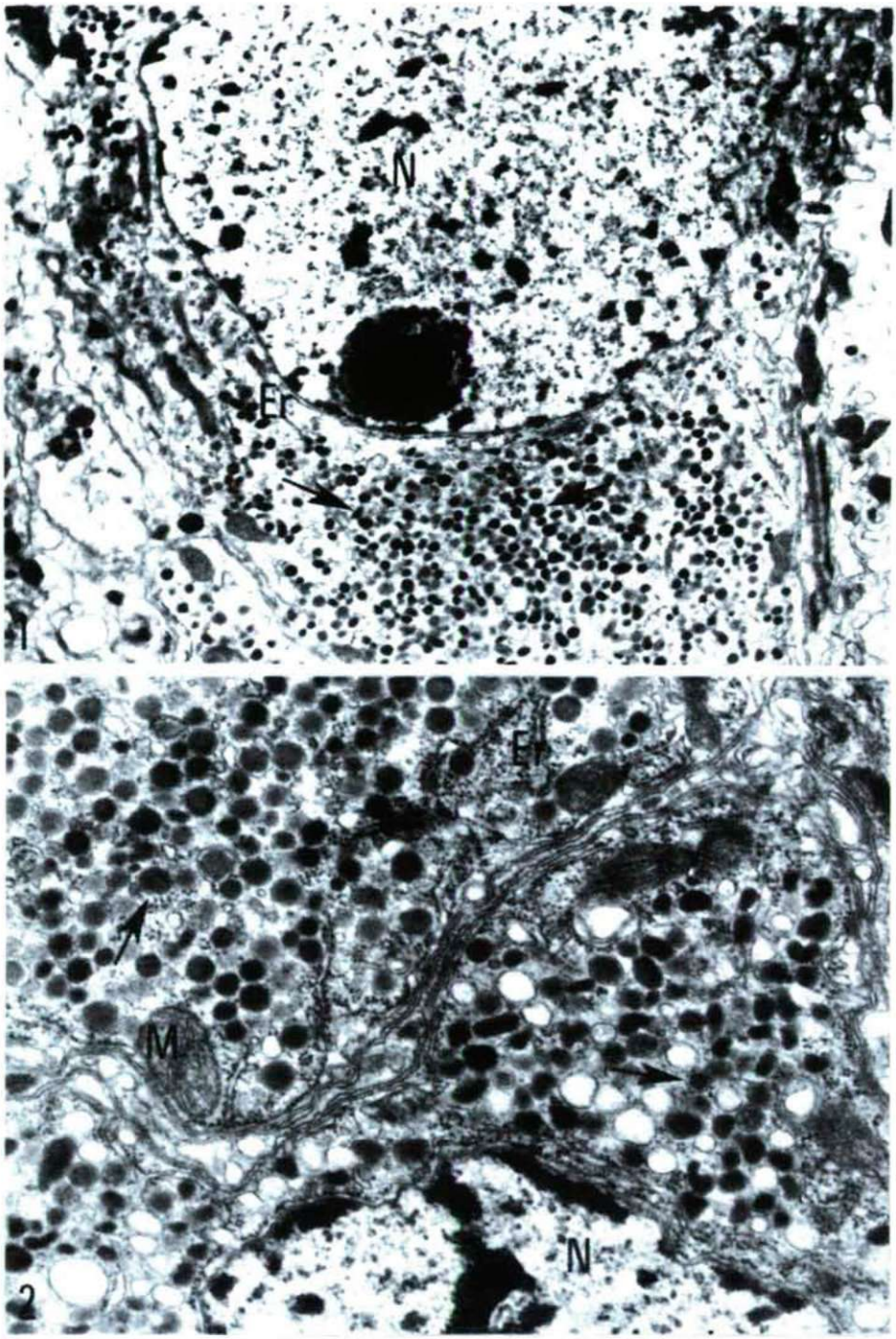
The newly formed cerebral ganglion is closer to the dorsal wall of the pharynx than to the epidermis. When the regeneration tissue disappears, the new cerebral ganglion is separated from the epidermis while it still remains in contact with the wall of the pharynx. These observations indicate that the pharyngeal epithelium is more important concerning the regeneration of the cerebral ganglion than the epidermis.

During the regeneration process of the subesophageal ganglion serotonin immunopositive fibers appear in the "scar tissue" first, followed by the emergence of serotonin positive cells (Table II, Fig. 3). The ganglion has no connective tissue capsule and the fibers run parallel in dorsoventral direction in this early phase of regeneration.

After the 10th day, the capsule develops and the general appearence of serotoninergic elements resembles to the normal ganglion. Although no quantitative analysis has been made yet, it is obvious that there are less serotoninergic elements in the regenerated ganglion than in the intact one. The cerebral ganglion emerges as two bundles originating from the anterior pole of the regenerated subesophageal ganglion, forming the connectives first. Around the 15th day they unify and give rise to a tissue mass which slowly increases, and forms the cerebral ganglion. Both in the regenerating connectives and the brain serotonin immunopositive fibers appear first, and around the 20th day, serotonin immunopositive cells are present. Their number and distribution, however differ from the normal ganglion.

⇦ Table III. Fig. 1. Medioventral serotoninergic cell of a segmental ganglion. Er: endoplasmic reticulum; G: Golgi-complex, L: lipid droplet; N: nucleus. Arrows show dense-core vesicles. 18500x

Fig. 2. Laterally located serotoninergic cell of a segmental ganglion. Er: endoplasmic reticulum; G: Golgi-complex; N: nucleus. 22500x


N
ER
M
N

Quantitative estimates of monoamine content of the nervous system in earthworm have been performed utilizing less accurate methods (EULER, 1949; MYHRBERG, 1967; ÖSTLUND, 1954; RUDE, 1969). It is concluded that there is more serotonin in the central nervous system of annelids and mollusca than in that of arthropods (EVANS, 1980; GARDNER and CASHIN, 1975; WELSH and MOOREHEAD, 1960).

The main purpose of the present work is to detect the changes of serotonin content during the regeneration of different parts of the nervous system in earthworm. According to our preliminary study dynamic changes occur during the regeneration process. The first period lasts for three days after removing the cerebral ganglion and it is characterized by a reduction of serotonin content in intact ganglia, although the degree of reduction varies. The explanation for this lower serotonin content can either be a reduced production or an increased utilization.

After the third day regeneration the serotonin level gradually increases until the 17th postoperative day, when it is 2.5-6 fold higher than in control specimens. By day 20 (the longest postoperative period studied so far), the serotonin level tends to decrease again.

BIANCHI et al. (1988) and DE VRIES-SCHOUMACKER (1977) presumed that the monoaminergic cells in the nervous system of the earthworm play an endocrine role. Our present finding strongly support that there is an interrelationship between the serotonin content and the regeneration process of the nervous system in earthwoms, although the exact nature of this still remains obscure.

Summary

Numerous serotoninergic neurons and fibers are present in the subesophageal as well as segmental ganglia of the earthworm, *Lumbricus terrestris*. These cells were demonstrated by immunohistochemical and electron microscopy methods. During the regeneration of the brain the new serotoninergic element (fibers and cells) and changes in the serotonin contents of the regenerating nervous tissue were studied. The new serotoninergic elements appeared similar to the normal by the 17th postoperative day. To this time the level of serotonin content gradually increases, later it decreases.

Our result support the hypothesis that serotonin affects the regeneration processes of the nervous system in the earthworm.

⇦ Table IV. Fig. 1. Dorsal serotoninergic cell of the cerebral ganglion. Er: endoplasmic reticulum; N: nucleus. Arrows show dense-core vesicles. 12000x

Fig. 2. Lateral serotoninergic cell of the dorsal ganglion. Er: endoplasmic reticulum; M: mitochondrium; N: nucleus. Arrows show dense-core vesicles. 24000x

Acknowledgements

The authors wish to thank Dr. T. GÖRCS for providing the serotonin antiserum, and Mrs. EDIT KISS for her skillful technical assistance.

References

ANCTIL, M. J.-P., DEE WAELE, M.-J. MIRON, and PANI, A. K. (1990): Monoamines in the nervous system of the tube-worm *Chaetopterus variopedatus* (Polychaeta): Biochemical detection and serotonin immunoreactivity. - Cell. Tiss. Res. *259*, 81-92.

BERG, D. K. (1984): New neuronal growth factors. - Ann. Rev. Neurosci. *7*, 149-170.

BIANCHI, S., DI COSMO, ANNA and IAMUNNO, G. (1988): Fluorescence-histochemical and ultrastructural research on the monoaminergic neurosecretory cells of the earthworm *Octolasium complanatum* (Annelida: Oligochaeta). - Gen. Comp. Endocr. *71*, 243-256.

CHAPRON, C. (1970): Etude histologique infrastructurale et expérimentale de la régénération céphalique chez le lombricien *Eisenia foetida unicolor* (SAV.). - Ann. Embriol. Morphogen. *3*, 235-250.

CLARK, M. E. (1966): Histochemical localization of monoamines in the nervous system of the polychaete Nephtys. - Proc. Roy. Soc. B. *165*, 308-325.

CORNEC, J. P., CRESP, J., DELYE, P., HOARAU, F., and REYNAUD, G. (1987): Tissue responses and organogenesis during regeneration in the oligochaete *Limnodrilus hoffmeisteri* (CLAP). - Can. J. Zool. *65*, 403-414.

EHINGER, B., FALCK, B. and MYHRBERG, H. E. (1968): Biogenic monoamines in *Hirudo medicinalis*. - Histochemie *15*, 140-149.

EHINGER, B. and MYHRBERG, H. E. (1971): Neuronal localization of dopamine, noradrinaline, and 5-hydroxytryptamine in the central and peripheral nervous system of *Lumbricus terrestris* (L.). - Histochemie *28*, 265-275.

EULER, U. S. v. (1949): Noradrenalin und Histamin als Wirkstoffe vegetativer Nerven. - Z. Vitamin- Hormon- u. Fermentforsch. *2*, 596-608.

EVANS, P. D. (1980): Biogenic amines in the insect nervous system. - Adv. Insect. Physiol. *15*, 317-475.

FRIEDLÄNDER, B. (1888): Beiträge zur Kenntnis des Centralnervensystem von *Lumbricus*. - Z. Wiss. Zool. *47*, 49-84.

GARDNER, C. R. and CASHIN, C. H. (1975): Some aspects of monoamine function in the earthworm (*Lumbricus terrestris* L.). - Neuropharm. *14*, 495-500.

GÖRCS, T., LIPOSITS, ZS., PALAY, S. L., and CHAN-PALAY, V. (1985): Serotonin neurons on the ventral brain surface. - Proc. Natl. Acad. Sci. USA. *82*, 7449-7452.

GÜNTHER, J. (1971a): Der cytologische Aufbau der dorsalen Riesenfasern von *Lumbricus terrestris* L. - Z. Wiss. Zool. *183*, 51-70.

GÜNTHER, J. (1971b): Mikroanatomie des Bauchmarks von *Lumbricus terrestris* L. - Z. Morphol. Tiere. *70*, 141-182.

HERLANT-MEEWIS, H. (1962): Neurosecretory phenomena during regeneration of nervous centres in *Eisenia foetida*. - In: H. HELLER and R. B. CLARK (eds.): "Neurosecretion". Acad. Press, New York, pp. 267-274.

HERLANT-MEEWIS, H. (1964): Regeneration in Annelids. - In: ABERCHROMBIE, M. and BRACHET, J. (eds.). Advances in morphogenesis. Acad. Press, N.Y. pp. 155-215.

JESSEL, T. M. (1988): Adhesion molecules and the hierarchy of neural development. - Neuron *1*, 3-13.

KARNOVSKY, M. J. (1965): A formaldehyde-glutaraldehyde fixative of high osmorality for use in electron microscopy. - J. Cell Biol. *27*, 137 A.

KORITSÁNSZKY, S. and HARTWIG, H. G. (1974): The regeneration of the monoaminergic system in the cerebral ganglion of the earthworm, *Allolobophora caliginosa*. A morphological and microspectrofluorimetrical analysis. - Cell Tiss. Res. *151*, 171-186.

LENGVÁRI, I., CSOKNYA, M., MERCHENTHALER, I. and HÁMORI, J. (1992): Immunohistochemical study of the nervous system in earthworm (*Lumbricus terrestris* L.). - Acta Biol. Hung. *43*, 253-258.

MYHRBERG, H. E. (1967): Monoaminergic mechanisms in the nervous system of *Lumbricus terrestris* (L.). - Z. Zellforsch *81*, 311-343.

MYHRBERG, H. E. (1972): Ultrastructural localization of monoamines in the central nervous system of *Lumbricus terrestris* (L.) with Remarks on neurosecretory vesicles. - Z. Zellforsch. *126*, 348-362.

ÖSTLUND, E. (1954): The distribution of catechol amines in lower animals and their effect on the heart. - Acta Physiol. Scand. *31*, 1-64.

REYNOLDS, E. S. (1963): The use of lead citrate at high pH as an electron-opaque stain in electron microscopy. - J. Cell. Biol. *17*, 208-212.

RUDE, S. (1966): Monoamine-containing neurons in the nerve cord and body wall of *Lumbricus terrestris*. - J. Comp. Neur. *128*, 397-412.

RUDE, S. (1969): Monoamine-containing neurons in the central nervous system and peripherial nerves of the leech, *Hirudo medicinalis*. - J. Comp. Neur. *136*, 349-372.

RUDE, S., COGGESHALL, R. E. and ORDEN, L. S. VAN. (1969): Chemical and ultrastructural identification of 5-hydroxytryptamine in an identified neuron. - J. Cell. Biol. *41*, 832-854.

SCHARRER, B. (1937): Über sekretorisch tätige Nervenzellen bei Wirbellosen Tieren. - Naturwissenschaften *25*, 131-138.

SPÖRHASE-EICHMANN, U., GRAS, H. and SCHÜRMANN, F.-W. (1987a): Patterns of serotonin-immunoreactive neurons in the central nervous system of the earthworm *Lumbricus terrestris* L. I. Ganglia of the ventral nerve cord. - Cell Tiss. Res. *246*, 601-614.

SPÖRHASE-EICHMANN, U., GRAS, H. and SCHÜRMANN, F.-W. (1987b): Patterns of serotonin-immunoreactive neurons in the central nervous system of the earthworm *Lumbricus terrestris* L. II. Rostral and caudal ganglia. - Cell Tiss. Res. *249*, 625-632.

STEPHAN-DUBOIS, F. (1956): Migration et différenciation des néoblastes dans la régénération antérieure de *Lumriculus variegatus*. - C. R. Seances Soc. Biol. Ses. Fil. *150*, 1239-1242.

STERNBERGER, L. A., HARDY, P. H. JR, CUCULLIS, J. J. and MEYER, H. G. (1970): The unlabelled antibody enzyme method of immunohistochemistry. Preparation and properties of soluble antigen-antibody complex (horseradish-peroxidase-anti-horseradish-peroxidase) and its use in identification of spirochetes. - J. Histochem. Cytochem. *18*, 315-333.

THIERY, J. P., BRACKENBURY, R., RUTISHAUSER, U., and EDELMAN, G. M. (1977): Adhesion among neural cells of the chick embryo. II. Purification and characterization of a cell adhesion molecule from neural retina. - J. Biol. Biochem. *252*, 6841-6845

VRIES-SCHOUMACKER, DE H. (1977): Fluorescence and ultrastructural localization of aminergic neurons in the nerve cord of *Eisenia foetida* (Annelida-Oligochaeta). - Cell Tiss. Ress. *185*, 351-360.

ZAMBONI, L. and DE MARTINO, L. (1967): Buffered picric acid-formaldehyde: A new rapid fixative for electron microscopy. - J. Cell Biol. *35*, 148B.

ZHINKIN, L. (1936): The influence of the nervous system on the regeneration of *Rhynchelmis limosella*. - J. Exp. Zool. *73*, 43-65.

WELSH, J. H. and MOOREHEAD, M. (1960): The quantitative distribution of 5-HT in the invertebrates, especially in their nervous system. - J. Neurochem. *6*, 146-169.

ACTA BIOL. SZEGED. 39. pp. 51-58 (1993)

NEURAGIN AS AN IMMEDIATE EARLY GENE PRODUCT *

I. ROJIK, S. HUSZTA and O. FEHÉR

Department of Comparative Physiology, József Attila University
H-6701 Szeged, P.O.B. 533, Hungary

(Received: August 5, 1993)

Abstract

Time relations and regulation of neuragin synthesis were examined with the glycine labeling method in the cerebral cortex of the rat. During activation of the somato-sensory area, 2 min. stimulation sufficed to provoke the appearance of neuragin in the neurons. The newly synthesized protein persisted in the nerve cells at least for 6 hours after the end of stimulation. Phorbol-12-monoacetate strongly enhanced, sphingosin depressed the synthesis of neuragin. It is concluded, that neuragin is an immediate early gene product, similar to proteins encoded by genes c-fos and c-jun.

Key word: neuragin.

Introduction

ROJIK and FEHÉR (1976) investigated the fate and incorporation of amino acids in situ functioning cerebral cortex. To this aim they placed on the cortical surface filter paper strips containing labeled amino acids and kept them there for varying times, typically for one hour, excised the underlying cortical tissue, fixated them and subjected the samples to light- and electron-microscopic autoradiography. This experimental paradigm proved to be suitable to decide if the applied amino acids entered the cortical tissue and were incorporated into proteins.(ROJIK and FEHÉR, 1976).

After having examined the fate and incorporation of glutamic, aspartic, gamma-aminobutyric acids and leucine, in case of glycine they observed, that this amino acid was not only incorporated into neural proteins, but this was highly dependent on the intensity of cortical function. During intensive cortical activity the incorporation of glycine was multiply higher than at rest. In presence of cycloheximide labeled glycine was not built in. An important additional finding was, that labeled glycine appeared under these circumstances only in nerve cells. In course of biochemical investigations (not yet published) it turned out, that for labeling of neurons in the stimulated neural

* This paper is dedicated to the centennial anniversary of Prof. AMBRUS ÁBRAHÁM's birth.

structures a glycine rich protein (of about 200 kDa molecular weight), called by us neuragin, can be made responsible.

Since glycine autoradiography proved to be an excellent morphological indicator of neural activity, it was exploited in the physiological analysis of a good number of neural structures. Identification of neuron populations generating well defined electric signals was successfully carried out in somato-sensory, auditory, visual and motor cortices of cats and rats, in the thalamo cortical system and hippocampus of rats and in the spinal cord of frogs (ROJIK and FEHÉR, 1979, 1980, 1986a,b; ROJIK et al, 1983, 1984, 1987; TOLDI et al. 1985).

A somewhat problematic feature of this experimental paradigm was, that it has no temporal dimension, i.e. it fails to indicate the sequence of activation of different neural elements. As a first step to eliminate this failure seemed to be suitable to assess, what is the earliest time at which the glycine labeling appears, after onset of activity. Another related problem was, how long newly synthesized neuragin survives after cessation of stimulation. In this paper several observations will also be published about localization of neuragin within the neuron.

Material and Methods

Rats weighing about 250 g were anaesthetized with 1.2 g/kg urathane, intraperitoneally. The skull was opened on both sides and the cerebral hemispheres exposed. The dura was not removed, because this thin membrane did not hinder considerably the diffusion of the substances applied to the surface. The skull was fixed in a stereotaxic frame. Two steel needles were pierced into the right whisker region for activation of the left somato-sensory area. Impulses having 2/s frequency, 15 V voltage and 0.3 ms duration were capable of activating the whole barrel field and most part of the contralateral somato-sensory area. Cortical activation was in each experiment tested by recording evoked field potentials.

[^{3}H]-glycine was applied in the following manner. Solution of [^{3}H]-glycine was prepared 2x2 mm pieces of filter paper were soaked in it and dried under infrared lamp, so as to contain 3.10^6 dpm each. One piece of filter paper was placed on both somato-sensory areas. The right hemisphere serves as resting control, the left hemisphere was thrown in activity by stimulating the whisker region of the right side. After having finished the stimulation, the cortical areas, underlying to the filter papers were excised, fixed in Bouin or paraformaldehyde solution and processed for light- or electron microscopic autoradiography. Exposition lasted for 10 weeks. About further details of the procedure see ROJIK and FEHÉR (1976). Besides electric stimulation the effect of phorbol-12-acetate was also examined, as an activator of protein-kinase C (PKC).

The chemicals used were: [^{3}H]-glycine (Magyar Izotop Intézet, 92.5 GBq/ mM), Phorbol-12-monoacetate, (Sigma), sphingosine sulphate (Sigma), Ilford photo-emulsion for autoradiography.

Results

For detection of earliest appearance of neuragin in the cortical neurons, the following experimental procedure was adopted. One piece of filter paper strip containing labeled glycine was laid on both hemispheres and left there for 20 min., at rest. Thereafter the right whisker area was stimulated with the above parameters for 2,

5, or 10 min., respectively, in different animals. Then the underlying cortical samples were excised and processed as usual. The introductory 20 min. period served to prevent diffusion artifacts in the sections and assure, that differences between the two sides could be ascribed only to stimulation. The long incubation time and short stimulation period excluded interferences from side of vasomotor effects. As it can be seen in Fig. 1B, already after 2 min. of stimulation significant labeling in the left side cortical sample appeared as compared with the contralateral resting control (Fig. 1A). This indicated, that synthesis of neuragin must have started with onset of cortical excitation. Such a fast activation of genes could be observed only in case of immediate early genes. At longer stimulation periods (5 or 10 min.),the labeling caused by neuragin became even more intensive (Fig. 1C). In order to clear up, whether proteinkinase C, known to be involved into the stimulus- transcription chain, is participating in regulation of neuragin synthesis, the actions of the PKC activator, phorbol-12-monoacetate (Pha) were examined. To this aim, Pha in 10 μM concentration and glycine were applied to the right hemisphere without stimulation, for one hour. On the left side only glycine was laid. As it can be seen in Fig. 2A. activation alone was able to enhance the synthesis of neuragin and the labeling was considerably higher than on the control right side, also in absence of sensory stimuli. The relatively long duration of Pha application made it sure, that the drug reached the deepest layers of the cortex. The appearance of neuragin at these depths indicated, that diffusion of Pha was complete and PKC activation was present in the whole cortical depth (Fig. 2B).

When together with the Pha also 10 μM sphingosin, an antagonist of Pha in activating PKC, was applied, the synthesis of neuragin seemed to be rather depressed and the labelling by glycine incorporation scarcely differed from that in the untreated control (Fig. 2A and C).

The next question to be answered was the lifetime of the newly synthesised neuragin in the cortex. This was examined in the following way. The usual quantities of glycine were applied to both sides, but the left hemisphere was activated by stimulating the right whisker area for one hour. Then stimulation was stopped and the brain was left at rest for 2, 4 or 6 hours respectively, in different animals. The right hemisphere was resting control also in this case. In Fig. 1D-G it is demonstrated, that after lapse of 6 hours neuragin was present in the cortex, if not very abundantly and with somewhat different localization than in samples taken out after 1 hour rest. In these, neuragin filled out the cytoplasm and was richly present in the nucleolus (Fig. 1E and 3), while the nucleus was relatively free of it. In the 6 hour samples the neuragin was concentrated in the nuclear membrane, arranged in a spoke-like manner (Fig. 1G). When explaining this change of distribution one is led to think that i) neuragin was broken down by protease, and/or ii) was transported towards peripheral extensions of the neuron. In earlier examinations the evidences were favourable for the latter possibility.

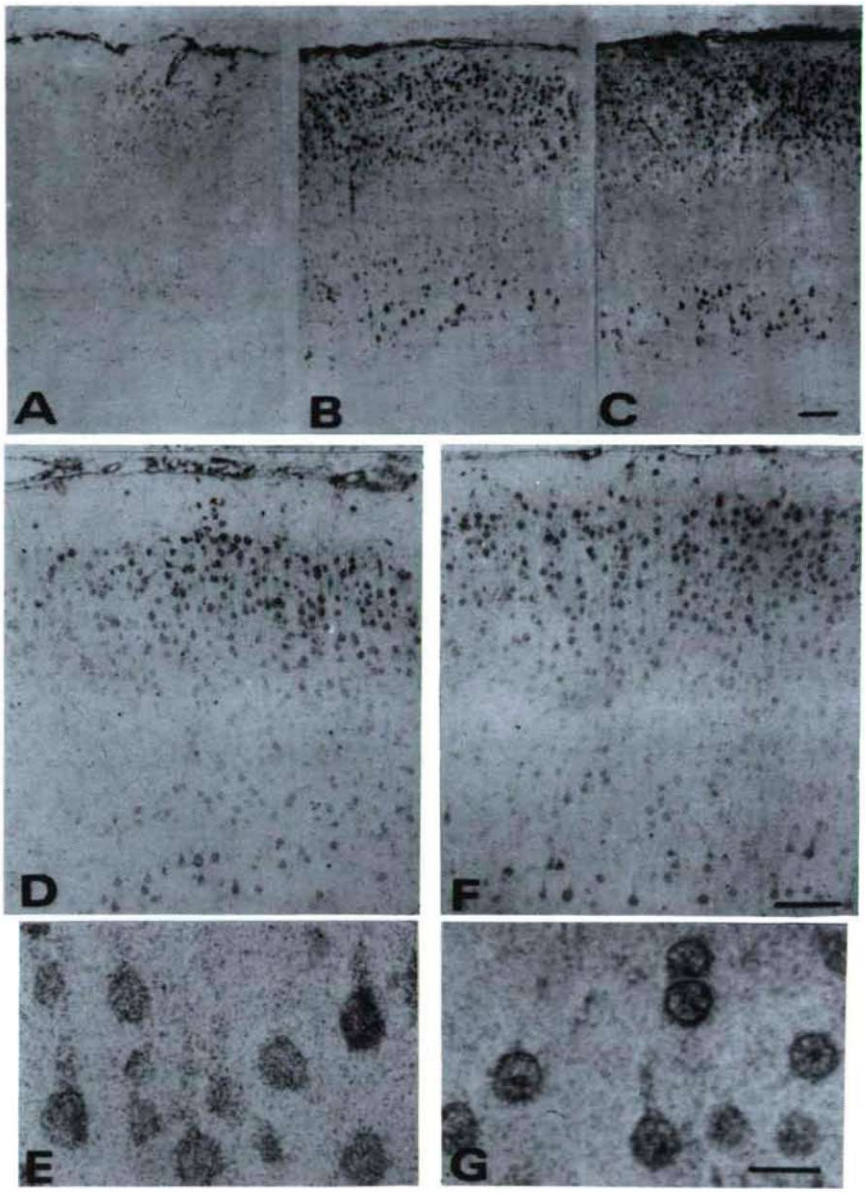


Fig. 1. Autoradiographic picture of somato-sensory cortex of rat. A. Resting control from the right side. B. Incorporation of labelled glycine after 2 min, C.after 10 min stimulation of the whisker area. D. labelling of the cortex after 1 hour rest following 1 hour peripheral stimulation, E. the same at higher magnification, F. The same after 6 hours rest following stimulation, G. The same with higher magnification. Light microscopic autoradiography, Ilford emulsion, Exposition time:10 weeks. Calibrations : 200 μm in A, B, C, D, and F; 20 μm in E and G.

Discussion

The purpose of this work was to take under examination some possible analogies between immediate early gene products and the protein, neuragin, discovered by us in the early seventies. The experimental data presented here allow some conclusions in this respect. First, the time course of initiation of synthesis shows obvious parallelisms with that of early gene products. In our experiments 2 min. of sensory stimulation was sufficient to provoke neuragin synthesis and make appear newly synthesized protein molecules of 200 kDa molecular weight. This tends to show, that the whole synthetic apparatus was in a state of readiness and awaiting only for some trigger stimulus. In the experiments of COSTA et al. (1991) after PTZ induced seizures of 20-36 second duration a significant Fos-like immunreactivity (FLI) was observable in hippocampus of the rat. Essentially the same was reported by GASS et al. (1992) after bicuculline induced seizures lasting for 15 min. BULLITT et al. (1992) applied noxious stimuli enduring from 3 s to 24 hours to rat nerves and assessed FLI in the spinal cord. After the shortest exposition to noxious stimuli FLI was present and with prolongation of stimulation periods it became more and more intensive.

As to the endurance of the immediate early gene products larger variability of data is encountered. GASS et al. (1992) claim, that KROX-2 and c-Fos returned to the base level within 8 hours, while Fos-B and Jun remained above normal until 24 hours. According to MULLER et al. (1984) and CURRAN et al. (1984) the half lifetime of the Fos protein was 2 hours. Although in our experiments was not attempted to determine the time when the newly synthesized neuragin from the neurons completely disappears, the pictures obtained at 6 hours after stimulation point to similar time course of disappearance as with Fos and Jun.

As links in the second messenger system leading to activation of the genetic apparatus, the growth factors and calcium are emphasized, there are also observations in favour for the role of phorbol esters in these events. Thus MORGAN and CURRAN (1989) found phorbol esters to be relatively weak activator of c-fos expression in PC-12 cells of the rat, but in the human cell line they were much more potent in this respect. FISCH et al. (1987) and GILMAN (1988) report about unequivocal effects of phorbol esters on immediate early gene activation.

Although to date nothing is known about regulation of neuragin synthesis, these analogies indicate that neuragin represents one of the proteins ubiquitous in the nervous system, being apparently closely involved in basic processes of the stimulus-transcription coupling. It may be noted, that some glycine rich proteins are abundant in plants and play important role in excited states and in regeneration of plant cells (KELLER et al, 1988).

Acknowledgment

This work was supported by the OTKA N^{O} 427 grant.

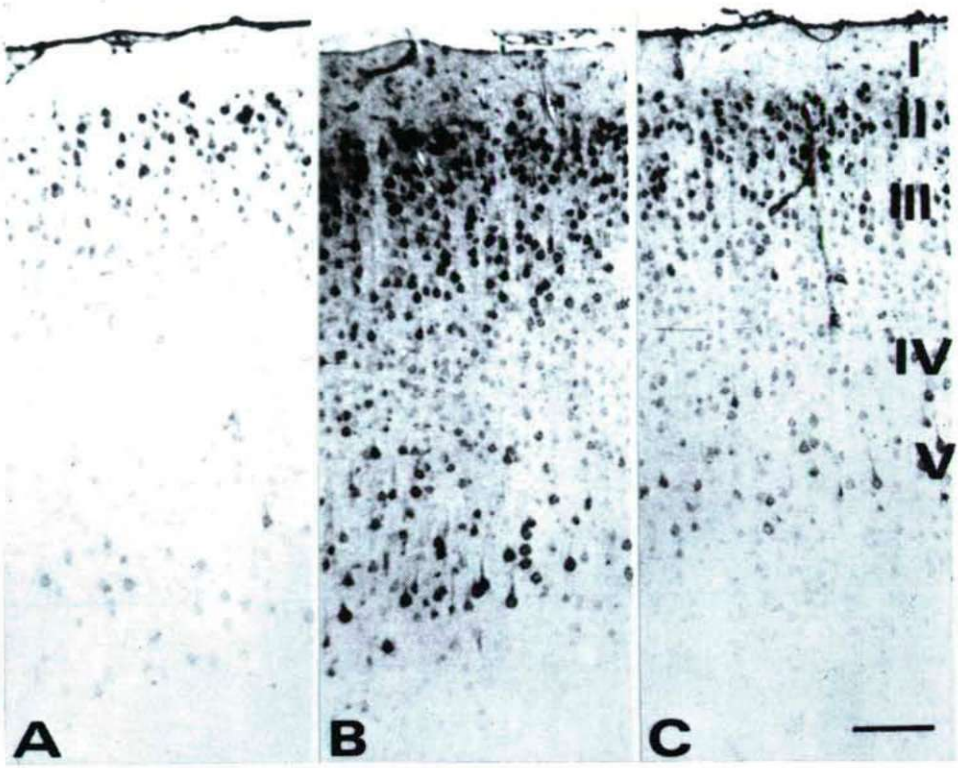


Fig. 2. Autoradiographic picture of the somato-sensory cortex of the rat. A. resting control, B.after 1 hour application of 10 μM phorbol-12-,monoacetate, C. the same in presence of 10 μM sphingosine sulphate. Roman numerals on the right denote cortical layers. Calibration:200 μm.

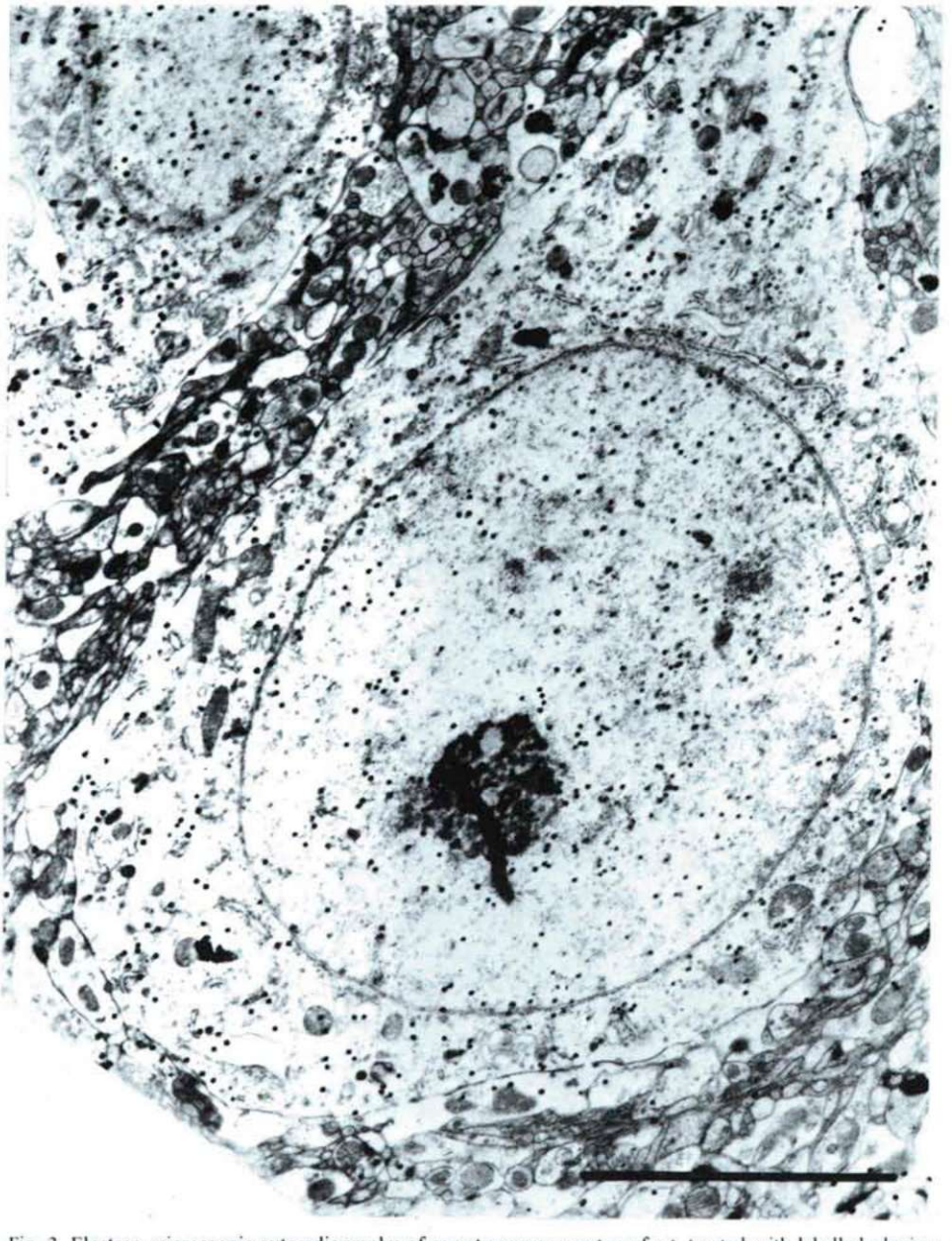


Fig. 3. Electron microscopic autoradiography of somato-sensory cortex of rat, treated with labelled glycine, after 1 hour stimulation. Small pyramid from layer III. Exposition time: 10 weeks, developed with Phenidon. Calibration: 5 μm.

References

BULLITT, E., LEE,C.L., LIGHT, A.R. and WILLCOCKSON, H. (1992): Induction of c-fos-like protein within the lumbar spinal cord and thalamus of the rat following peripheral stimulation. - Brain Res. *493*, 391-397.

COSTA, A.D., BREESE, C.R., BOYD, R.L., BOOZE, R.M. and SONNTAG, W.E. (1991): Attenuation of fos-like immunoreactivity induced by a single electroconvulsive shock in brains of aging mice. - Brain Res. *567*, 204-211.

CURRAN, T., MILLER, A.D., ZOKAS, L. and VERMA, I.M. (1984): Viral and cellular fos proteins: A comparative analysis. - Cell *36*, 259-268

FISCH, T.M., PRYWES, R. and ROEDER, R.G. (1987): c-fos sequences necessary for basal expression and induction by epiderma growth factor,12-O-tetradecanoyl phorbol-13-acetate and the calcium ionophore. - Mol. Cell. Biol. *7*, 3490-3502

GASS, P., HERDEGEN, T., BRAVO, R. and KIESSLING, M. (1992): Induction of immediate early gene encoded proteins in the rat hippocampus after bicuculline-induced seizures - Differential expression of KROX-24,FOS and JUN proteins. - Neuroscience *48*, 315-324.

KELLER, B., SAUER, N. and LAME, C.J. (1988): Glycine-rich cell wall proteins in bean: gene stucture and association of the protein with the vascular system. - EMBO Journal *7*, 3625-3633.

MORGAN, J.I. and CURRAN,T.,(1989): Fos and the immediate-early response in the central nervous system. - In: Colburn, N.H. (ed.): Genes and Signal Transmission in Multistage Carcinogenesis. pp. 377-390. Dekker New-York.

MULLER, R., BRAVO, R., BURCKHARDT, J. and CURRAN, T. (1984): Induction of c-fos gene and protein by growth factors precedes activation of c-myc. - Nature *312*, 716-720.

ROJIK, I. and FEHÉR, O. (1976): Jelzett aminosavak beépülésének vizsgálata agykérgen. - Kisérletes Orvostudomány *28*, 186-201.

ROJIK, I. and FEHÉR, O. (1979): Incorporation of labelled amino acids into the acoustic cortex of the cat. - Acta Biol. Acad. Sci. Hung. *30*, 209-222.

ROJIK, I. and FEHÉR, O. (1980): Correlation between glycine incorporation and cerebral cortical activity. - Exp. Brain Res. *39*, 321-326.

ROJIK, I., BARANYI, A., TURY, G. and FEHÉR, O. (1983): Function dependent glycine incorporation into neurons of the cat motor cortex. - Acta Biol. Hung. *34*, 257-266.

ROJIK, I., TOLDI, J. and FEHÉR, O. (1984): Afferent fibers to the anterior suprasylvian gyrus from the medial geniculate body of cat. - Neurosci. Lett. *51*, 43-46.

ROJIK, I. and FEHÉR, O. (1986a): A study on the tonotopic organization in the auditory cortex of the cat.An application of the glycine labelling method. - Acta Physiol. Hung. *67*, 377-386.

ROJIK, I. and FEHÉR, O. (1986b): Investigation of neuronal transport in the cerebral cortex of the cat. - Neuroscience *19*, 1187-1196.

ROJIK, I., BARANYI, A., BUZSÁKI, G., URBÁN, L. and FEHÉR, O. (1987): Application of the glycine labelling method to the cerebellum,hippocampus and spinal cord. - Acta Biol.Hung. *38*, 393-407.

TILMAN, M.J. (1988): The c-fos serum response element responds to protein kinase C-dependent and - independent signals but not to cyclic AMP. - Genes Dev. *2*, 394-402.

TOLDI, J., ROJIK, I. and FEHÉR, O. (1985): The functional projections of the anterior ventralis nucleus,as revealed by autoradiography. - Neurosci. Lett. *58*, 61-66.

ACTA BIOL. SZEGED. 39. pp. 59-69 (1993)

THE SPORE MORPHOLOGY OF HEPATICAE SPECIES

A. VOJTKÓ

Botanical Department of the Teachers' College H-3301 Eger P.O.B. 43. Hungary

(Received: July 1, 1992)

Abstract

This paper provides further details to the characterization of the spores of *Hepaticae* species distributed in Hungary. The main spore morphological data of the 29 species are based on light microscopic investigations. These features are: spore-forms, middle size, size range, thickness of spore-walls, ornamentation. Samples are derived from herbarial materials fixed with glycerin. The examined spores are documented with light microscopic photos.

Key words: palinology, *Hepaticae*, LM morphology.

Introduction

The exact description of spore-forms is necessary to characterize moss species (e.g. BISCHLER, 1982; MCQUEEN, 1985; JOVET-AST, 1986) and at the same time taxonomic and systematic conclusions can be drawn from the morphological characterization (SORSA-KOPONEN, 1973; JÁRAI-KOMLÓDI, 1974; JÁRAI-KOMLÓDI and ORBÁN, 1975).

The characterization of spore is very important because there are some genera in which species can be surely determined only on the basis of the spore structure (*Fossombronia, Sphaerocarpos, Riccia*), the handbooks of mosses features of spores are described in (MÜLLER, 1957; LANDWEHR, 1980; ORBÁN and VAJDA, 1983).

The dispersal of the species is influenced by spore sizes. Spores give different reproductive chances to their own species by means of their different sizes and spreading efforts. According to theoretical calculations the spores of 20 μm are transported in a cycle with 1000 km long axis, spores of 50 μm can be carried only to a distance of 40 km and the spores of *Archidium* with 250 μm gets to only 1 km (ZANTEN, 1977; MOGENSEN, 1981).

The examination of the recent Hungarian moss spores consists of mainly the work of JÁRAI-KOMLÓDI (JÁRAI-KOMLÓDI, 1974; JÁRAI-KOMLÓDI and ORBÁN, 1975; BOROS and JÁRAI-KOMLÓDI 1975). In order to describe spores exactly she uses the terminology of ERDTMAN in her works. During my examinations I choose species which are not found in her descriptions.

Material and methods

The examined spores of *Hepaticae* are from some materials of herbaria. Botanical Department of the Hungarian Natural History Museum (TTM). In order to collect spores I went through the herbarium of the Botanical Department in the Teachers' College of Eger (EGR). The species were collected by Á. BOROS and L. VAJDA and were determined mainly by L. VAJDA. The collection includes the whole flora of the Carpathian Basin.

Fixing and photography:

I used two kinds of methods in fixing: fixing with glycerin and the more simple Hoyer solution which is used by the bryologists many times. Sometime this method seemed to be more usable because thinner preparatum could be made and here by it was better for the examination with immersion lens. (It is disadvantage that the spore is getting lighter after a time.) The gelatin with glycerin is made of 38 ml distilled water, 10 g gelatin and 48 ml glycerin (KEDVES, 1986). To make Hoyer solution 50 ml distilled water, 30 g rubber arabicum, 200 g cloralhidrate and 20 ml glycerin is needed (ORBÁN and VAJDA, 1983). The microphotographs were taken with Zeiss automatic photoapparat and mainly with HI 100/1.25 and 40/0.65 objectives.

Results

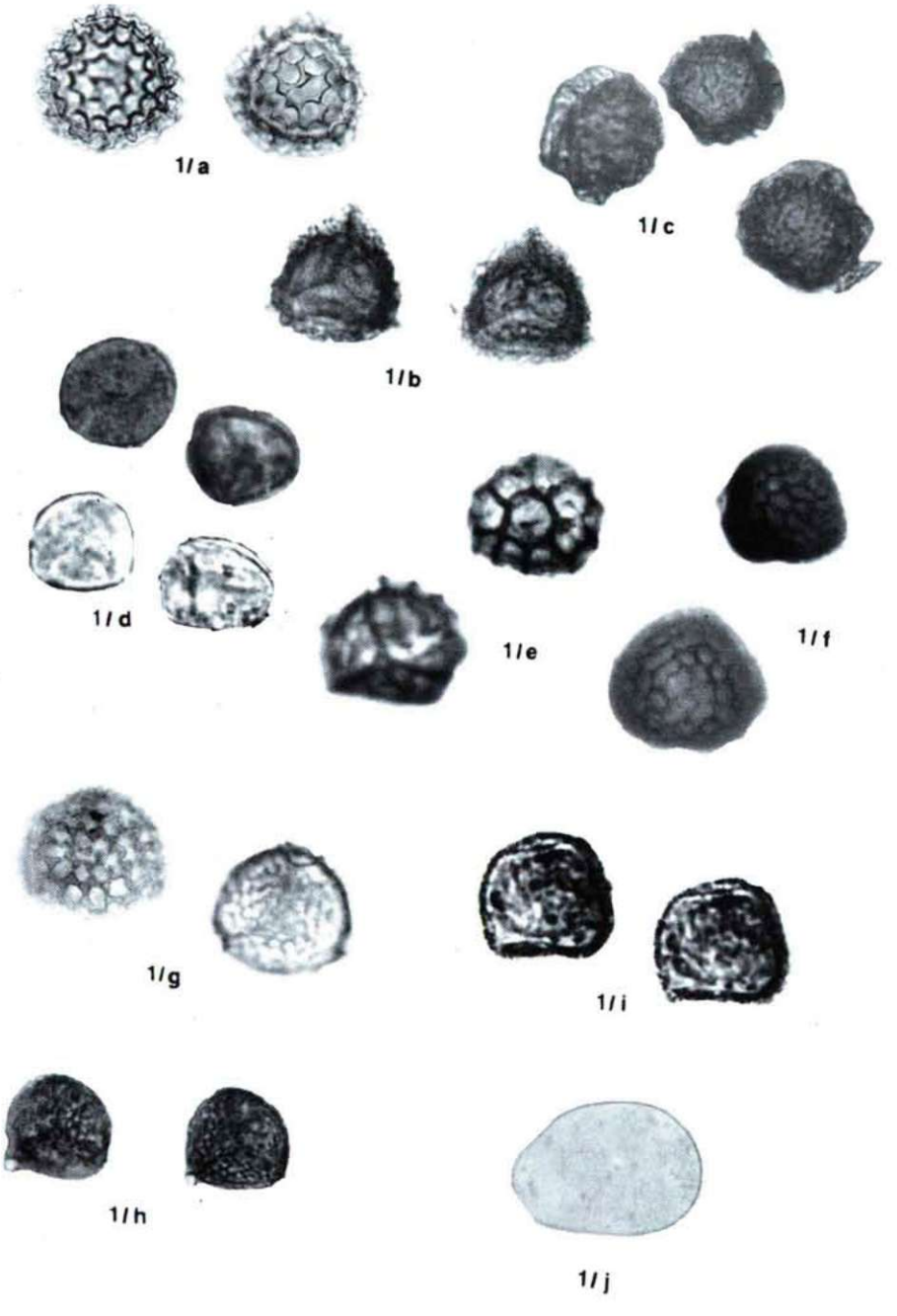
The examined moss spores are characterized on the basis of the following features: form, mean value, size range, spore wall thickness, ornamentation. These data may serve as an inquiry basis for the other fields of biology (e.g. evolution, taxonomy, ecology).

From among the spores of varied shapes of *Hepaticae* three types occurred in the examined material: globose, subtriangular, elliptic. The spores of *Riccia* species (3-3.5 μm) and *Frullania dilatata* (6-8 μm) are conspicuous with their thick walls (these types are subtriangular and they have big size, too).

The thinnest exosporium can be found in the spores of *Marchantia polymorpha* (0.8 μm). The only elliptic form is the spore of *Pellia endivifolia* and this is the biggest spore at the same time (80x65 μm) from among the examined ones.

Ornamentation can be seen well on the light microscopy photos mainly at the spores of big sizes so it is easier to characterize them. One of the most interesting phenomena is the tooth-like bacula of *Frullania dilatata* (see fig 3/I).

Fig. 1. a. *Mannia fragrans* (BALBIS) FRYE et CLARK (x250), b. *Asterella saccata* (WAHLENB) EVANS (x250), c. *Athalamia hyalina* (SOMM.) HATT (x250), d. *Marchantia polymorpha* L. BURGEFF (x1000), e. *Riccia duplex* Lorbeer in K. MÜLL. (x250), f. *Riccia sorocarpa* BISCH. (x250), g. *Riccia bifurca* HOFFM. (x250), h. *Riccia glauca* L. (x250), i. *Riccardia latifrons* (LINDB.) LINDB. (x1000), j. *Pellia endivifolia* (DICKS.) DUM. (x250).


1/a
1/c
1/b
1/d
1/e
1/f
1/g
1/i
1/h
1/j

Discussion and conclusions

The examined spores can be divided into three main types:

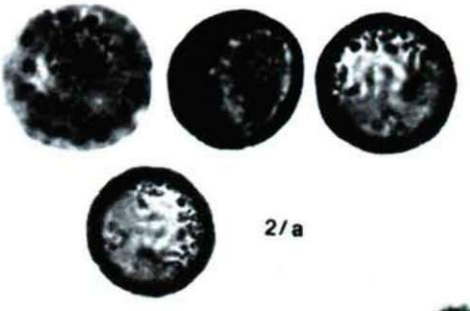
The firs one includes the subtriangular well separated spores which are typical of *Ricciaceae* and *Aytoniaceae* families in the size range of 45 μm and 75 μm with 3.5 μm thick spore-walls and ornamentation which can be hardly described (e.g. *Mannia fragrans, Asterella saccata, Riccia duplex, R. glauca, R. sorocarpa, R. bifurca*).

The second type contains families with globose-like, small (max. 20 μm) spores with thin walls (max. 2 μm). Their ornamentation are sometimes difficult to describe but it is mainly pilate and clavate-like (e.g. *Riccardia latifrons, Lophozia collaris, L. excisa, Jungermannia hyalia, Marsupella emarginata, M. hungarica, Plagiochila porelloides, Lophocoela cuspidata, Chiloscyphus pallescens, Cephaloziella integerrima, C. divaricata, C. stellulifera, C. rubella var. sullivanti, C. hampeana, Lepidozia reptans, Calypogeia suecica, C. trichomanis, C. integristipula, Blepharostoma trichophyllum*).

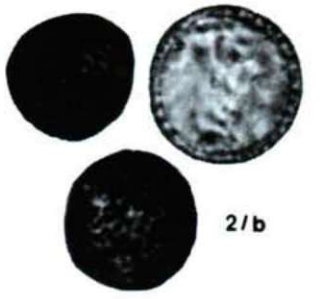
The third type consists of e.g. *Frullania dilatata* which has got a very interesting spore morphology. It is subtriangular, is 40x51 μm with particularly thick wall (6-8 μm) and its ornamentation is tooth-like bacula which is unique among the examined specimens.

The larger spores with globose type of *Athalamia hyalina* which has got a different morphology from the other and the also big and elliptic shaped spores of *Pellia endivifolia* with surprisingly thin spore walls can not be ranged among any main types either.

Fig. 2. a. *Lophozia collaris* (NEES.) DUM. (x1000), b. *Lophozia excisa* (DICKS.) DUM. (x1000), c. *Jungermannia hyalina* LYELL in HOOK (x1000), d. *Marsupella emarginata* (EHR.) DUM. (x1000), e. *Marsupella hungarica* BOROS et VAJDA (x1000), f. *Plagiochila porelloides* (TORREY et NEES) LINDENB. (x1000), g. *Lophocolea cuspidata* (NEES) LIMPR. (x1000).

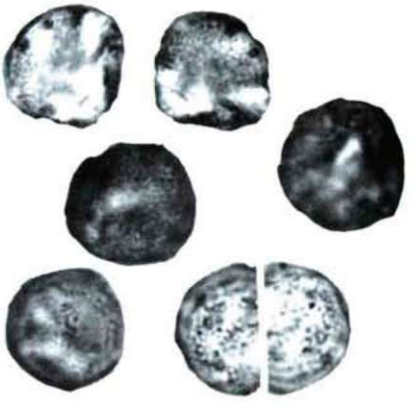


2/a



2/b

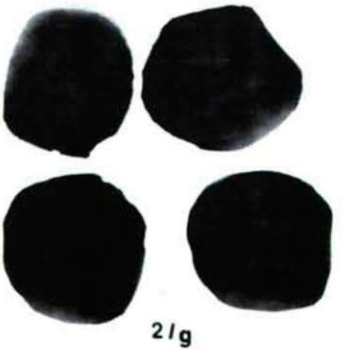
2/c



2/d

2/e

2/f



2/g

3/a

3/b

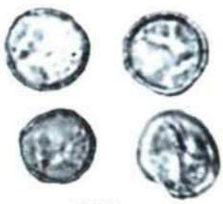
3/c

3/d

3/e

3/f

3/g

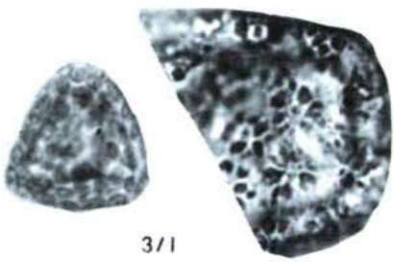


3/h

3/i

3/j

3/k



3/l

⇦ Fig. 3. a. *Chiloscyphus pallescens* (Ehrh. ex Hoffm.) Dum. (x1000), b. *Cephaloziella integerrima* (Lindb.) Warnst. (x1000), c. *Cephaloziella divaricata* (Sm.) Schiffn. (x1000), d. *Cephaloziella stellulifera* (Tayl.) Schiffn (x1000), e. *Cephaloziella raddiana* (Massal) Schiffn. (x1000), f. *Cephaloziella hampeana* (Nees) Schiffn. (x1000), g. *Lepidozia reptans* (L.) Dum. (x1000), h. *Calypogeia suecica* (Arn. et Pers) K. Müll. (x1000), i. *Calypogeia trichomanis* (L.) K. Müll. (x1000), j. *Calypogeia integristipula* Steph. (x1000), k. *Blepharostoma trichophyllum* (L.) Dum. (x1000), l. *Frullania dilatata* (L.) Dum. (x250 & x1000).

Table 1. Spore morphological data of Hepaticae

Species	Form	Mean value µm	Size range µm	Spore wall thickness in µm	Ornamentation p: proximal d: distal surface	Fig.
Mannia fragrans (BALBIS) FRYE et CLARK						
Szársomlyó, VAJDA						
1965/III/25.			46-52		p=spinulate	
EGR	subtriangular	52x44	38.5-47	2	d=spinulate	1/a
n=10						
Asterella saccata (WAHLENB) EVANS						
Szársomlyó, VAJDA						
1965/III/25.			52-66		p=pilate	
EGR	subtriangular	55x45	42-47	2	d=pilate	1/b
n=10						
Athalamia hyalina (SOMM.) HATT						
Bucses, VAJDA						
1964/VII/23.						
EGR	globose	59	52-67	1-1.5	rugulate	1/c
n=10						
Marchantia polymorpha L. BURGEFF						
Retyezát, VAJDA						
1968/VII/12.					p=verrucate	
EGR	subtriangular	13.5	11-16	0.8 (0.5)	d=verrucate	1/d
n=10						
Riccia duplex LORBEER IN K. MÜLL.						
Vésztő, VAJDA						
1954/IX/4.			47-70		p=pilate	
EGR	subtriangular	60x55	52-58	3-3.5	d= reticulate	1/e
n=5						
Riccia sorocarpa BISCH.						
Oltárkő, VAJDA						
1957/XI/2			68-80	p=pilate		
EGR	subtriangular	75x60	55-68	3-4	d=reticulate	1/f
n=10						
Riccia bifurca HOFFM.						
Timár, BOROS						
1948/VII/1.			46-53		p=rugulate	
EGR	subtriangular	51x46	44-49	3-3.5	d=reticulate	1/g
n=10						

Table 1. (continued)

Species	Form	Mean value µm	Size range µm	Spore wall thickness in µm	Ornamentation p: proximal d: distal surface	Fig.
Riccia glauca L. Ördögrét, BOROS 1957/XI/4. EGR n=10	subtriangular	71x65	60-75 56-68	3-3.5	p=baculate d=reticulate	1/h
Riccardia latifrons (LINDB.) LINDB. Bélai havasok, VAJDA 1978/VIII. TTM n=10	globose	18	15-20	2	clavate	1/i
Pellia endivifolia (DICKS.) DUM. Mocsárbükk, BOROS 1961/IV/9. EGR n=5	elliptic	80x65	70-100 40-70	1.5-2	verrucate	1/j
Lophozia collaris (NEES.) DUM. Garadna-völgy, VAJDA 1959/VII/28. EGR n=10	globose	20.4	18.2-22.2	1	clavate	2/a
Lophozia excisa (DICKS.) DUM. Nagymező, VAJDA 1957/VIII/27. EGR n=10	globose	23	22.2-24.6	1-1.5	pilate	2/b
Jungermannia hyalina LYELL in HOOK Kab-hegy, BOROS 1968/IV/15. EGR n=10	globose	17	15-19.6	0.8-1	pilate	2/c
Marsupella emarginata (EHR.) DUM. Chopok, SWEYKOWSKI 1956/VIII/28. TTM n=10	globose	12	11-13.8	1.2-1.5	pilate	2/d
Marsupella hungarica BOROS et VAJDA Nagyvasfazék-völgy, VAJDA 1960/VI/2. TTM n=10	globose	11	10-12.8	0.8-1	pilate	2/e
Plagiochila porelloides (TORREY et NEES) LINDENB. Eperjes, VAJDA 1951/IV/15. TTM n=10	globose	17.8	15-20	1.2-1.5	pilate	2/f

Table 1. (continued)

Species	Form	Mean value µm	Size range µm	Spore wall thickness in µm	Ornamentation p: proximal d: distal surface	Fig.
Lophocolea cuspidata (NEES) LIMPR. Bányai-völgy, VAJDA 1952/VII/24. EGR n=10	globose	20.4	17-25	1.5-2	pilate	2/g
Chiloscyphus pallescens (EHRH. ex HOFFM.) DUM. Magosfa, VAJDA 1958/V/2. EGR n=10	globose	15.2	11-18	0.8-1	pilate	3/a
Cephaloziella integerrima (LINDB.) WARNST. Ense et Loir, CH. DONIM 1910/I. TTM n=10	globose	7.2	6-9.6	0.8-1	pilate	3/b
Cephaloziella divaricata (SM.) SCHIFFN. Greinberg, LOESKE 1871/VIII/25. TTM n=10	globose	7	6.2-8.2	0.8-1	pilate	3/c
Cephaloziella stellulifera (TAYL.) SCHIFFN Ördögorom, VAJDA 1951/XII/2. EGR n=10	globose	8.8	7-10	0.8-1	pilate	3/d
Cephaloziella raddiana (MASSAL) SCHIFFN Leány-völgy, VAJDA 1959/VIII/5. EGR n=10	globose	7	6-8	0.8-1	pilate	3/e
Cephaloziella hampeana (NEES) SCHIFFN. Hollóháza, VAJDA 1954/VI/30. TTM n=10	globose	10	9-11.8	0.8-1	pilate	3/f
Lepidozia reptans (L.) DUM. Balázstanya, DEGEN 1911/VII/28. TTM n=10	globose	16.4	15-18	0.8-1.2	clavate	3/g
Calypogeia suecica (ARN. et PERS) K. MÜLL. Szeben, VAJDA 1968/VII/5. TTM n=10	globose	10.2	9.4-11.8	0.8-1	pilate	3/h

Table 1. (continued)

Species	Form	Mean value µm	Size range µm	Spore wall thickness in µm	Ornamentation p: proximal d: distal surface	Fig.
Calypogeia trichomanis (L.) K. MÜLL. 9923/H SCHIFFNER 1899/V/19. TTM n=10	globose	14.2	12-15.6	0.8-1	pilate	3/i
Calypogeia integristipula STEPH. Szent-Anna tó, VAJDA 1965/VIII/25. TTM n=10	globose	16.2	15-17.6	1-1.5	clavate	3/j
Blepharostoma trichophyllum (L.) DUM. Fehérvízvölgy, VAJDA 1974/VII/12. TTM n=10	globose	13.4	12.2-15.6	0.8-1	pilate	3/k
Frullania dilatata (L.) DUM. Krassó-Szörény, ORBÁN 1972/IX/14. TTM n=10	subtriangular	40x51	38-42 45-54	6 (7-8)	baculate (tooth-like)	3/l

Acknowledgements

Thanks to Prof. M. KEDVES for looking through the manuscript and his useful advice and to M. RAJCZY for placing the material of TTM my disposal.

References

BISCHLER, H. (1982): *Marchantia* L. Morphologie sporale, germination et rang taxonomique des Sections *Marchantia* et *Chlamidium* (CARDA) NEES. - Cryptogamie *3* (*4*), 351-364.

BOROS, Á. and JÁRAI-KOMLÓDI, M. (1975): An Atlas of Recent European Moss Spores. - Akadémiai Kiadó Budapest, pp. 466.

CLARKE, G.C.S. (1979): Spore morphology and bryophyte systematisc. - In: CLARKE, G.C.S. and DUCKETT, J.G. (eds.): Bryophyte Systematics. - Academic Press London, New York, pp. 231-250.

JÁRAI-KOMLÓDI, M. (1974): Comparative Spore Morphological Examinations in *Funaria* and Species. - Acta Bot. Hung. *20*, 71-81.

JÁRAI-KOMLÓDI, M. (1980): Módszertani tanulmány *Linum* virágpor-szemeken fény- (LM) és elektronmikroszkóppal (TEM, SEM) történő összehasonlító vizsgálatokhoz. (A methodological study for comparative examinations in pollen grains of *Linum* by means of light- (LM) and electron- (TEM, SEM) microscopes.) - Bot. Közlem. *67*, 37-47.

JÁRAI-KOMLÓDI, M. and ORBÁN, S. (1975): Spore Morphological studies on Recent European *Encalypta* Species. - Acta Bot. Hung. *21*, 305-345.

JOVET-AST, S. (1971-1972): Distinction de *Riccia gougetiana* MONT. et de *Riccia ciliifera* LINK. d.apres les spores. - Rev. Bryol. et Lichenol. *38*, 161-176.

JOVET-AST, S. (1986): Les *Riccia* de la region mediteraneenne. - Cryptogamie *3*, 287-431.

KEDVES, M. (1986): Introduction to the Palynology of prequaternary deposits. - Studia Biologica Hungarica *19*, 164 pp.

LANDWEHR, J. (1980): Atlas Nederlandse Levermossen. - Kominklijke Nederlandse Naturhistorische Vereiniging, 278 pp.

MCQUEEN, C.B. (1985): Spore Morphology of Four Species of *Sphagnum* in Section Acutifolia. - The Bryologist *88*, 1-4.

MOGENSEN, R.G.S. (1981): The Biological Significance of Morphological Characters in Bryophytes: The Spore. - The Bryologist *84*, 187-207.

MÜLLER, K. (1957): Die Lebermoosen Europas. - Akad. Verlagsgesellschaft Leipzig.

NAGY, E. (1968): Moss Spores in Hungarian Neogene Strata. - Acta Bot. Hung. *14*, 13-132.

NAGY, E. and KEDVES, M. (1988): State of palynological research in Hungary. - Acta Bot. Hung. *34*, 311-324.

ORBÁN, S and VAJDA, L. (1983): Magyarország mohaflórájának kézikönyve (Handbook of the Hungarian Moss Flora). - Akadémiai Kiadó Budapest 518 pp.

SORSA, P. and KOPONEN, T. (1973): Spore morphology of *Mniaceae* MITT (*Bryophyta*) and its taxonomic significance. - Ann. Bot. Fennici *10*,187-200.

ZANTEN, B.O. (1977): Experimental studies on transoceanic long-range dispersal of moss spores in the Southern Hemisphere. - Bryophytorum Bibliotheca 13.

ACTA BIOL. SZEGED. 39. pp. 71-75. (1993)

SUPPLEMENT TO THE REVISION OF THE GENUS CEROPALES LATREILLE. III. (HYMENOPTERA, CEROPALIDAE)

L. MÓCZÁR

H-1114 Budapest, Szabolcska M. u. 1. III/1. Hungary

(Received: June 1, 1993)

Abstract

New female of *Ceropales (Priesnerius) dubaica* MÓCZÁR is described and new distributional data are presented for this species and for two another insufficiently know, as well as, further species in Africa. New key for the variable *deserticola*-species group is given.

Part of the result on Ceropalids collected by Dr. A. MOCHI was published in former revisions (MÓCZÁR, 1986-1991). Present paper gives more comprehensive results on African Ceropalids based on Dr. A. MOCHI's collection. Most interesting ones of the species located are: *Ceropales dubica* MÓCZÁR, 1988 ♂, new ♀, *C. grahamstowni* MÓCZÁR, 1988 ♂,which have been known on the basis of a single male. Dr. A. MOCHI's collection makes possible to publish new distributional data on some insufficiently known interesting species, as well as to compile a new key for the largely variable *deserticola* species-group.

Subgenus *Priesnerius* MÓCZÁR, 1978

1 and - remain unchanged (MÓCZÁR, 1988: 122)

2 Pronotum tubercle normal, at most slightly thickened and not (♀) or hardly (♂) elongated below tegula; width of thorax herewidth as broad as, or distinctly narrower than the same at tegulae (meanwhile fore wings directed towards below). Tergite 7 not emarginate (♂). Tergite 9 without a row of dense erect hairs; ventral surface raised basally in a longitudinal, sharp keel and after a nearly rectangular declivity gradually flattened towards apex, tip pointed and scarcely turn up towards inside (♂). Posterior margin of pronotum yellowish white with ferruginous margin in front, often black laterally in the middle (♀ ♂) and also ferruginous along the lateral border (♂). Mesonotum black, with narrower, lateral and yellowish margins (♂). Tergites 1-3 with continuous, 4 with interrupted white bands, sometimes segments partly yellowish, partly dark ferruginous translucent. Legs largely brownish

ferruginous, only fore coxa partly black. The row of tomentose hairs on hind metatarsus not developed (♂). 4.5-6 mm.

polychloros GUSSAKOVSKIJ, 1931

- Pronotal tubercle conspicuously thickened i.e. seemingly swelled and elongated below tegula; the diameter of thorax here broader than across tegulae, viewed from above. Tergite 9 with a row of dense erect hairs (♂). Last abdominal tergite emarginate or impressed (♂). Light colour largely ivory, partly yellowish. Mesonotum with longitudinal spot medially and with streaks laterally. Legs nearly entirely ferruginous with yellowish white marking. The row of tomentose hairs on hind metatarsus not developed (♂). 3

3 Head and thorax largely black, with white colouring. Abdomen mostly brownish black, segment or tergites 1-2 (3-5) ferruginous with broad and continuous ivory white bands. Usually moderately light coloured species. Tergite 7 conspicuously broadly and deeply emarginated (♂). Fore coxa with black, ivory and ferruginous streaks. Sternite 9 pointed apically, ventral surface moderately raised basally, with a relative shorter row of dense erect hairs (♂, Fig. 8, Móczár, 1988: 153). Frons black, on larger specimen the two spots of ocular sinus sometimes connected in the middle (♀). ♀ 3.8-5.9, ♂ 4.6-5.3 mm.

dubaica MÓCZÁR, 1988

- Head, thorax with less black, more white and ferruginous colouring. Abdomen often entirely ivory-white, ferruginous basally, usually richely light coloured species. Tergite 7 normal, at most scarcely impressed (♂) medially. Fore coxa largely ivory with ferruginous spot 4

4 Head around ocelli and mesonotum smooth, shining with a few coarse punctures. Space semicircularly rounded interiorly. Propodeum largely black, lateral and often posterior margins broadly white or sometimes yellowish and ferruginous nearly entirely. Mesonotum with coarser punctures. Mesepisternum finely scattered punctured. Lower margin of last sternite straight in apical part (♀). Frons black, often with small yellowish spot, which rarely connected with dark brownish smaller line with the large spots of ocular sinus (♀) or with broad yellowish band (♂). Pronotum, segment 1 white nearly entirely, and laterally, as well as in front ferruginous; further segment ferruginous, only medially darker rufous, with broad ivory bands (♀). Hind tibia lined with yellow exteriorly. Sternite 9 hardly excised apically, slightly and shortly raised basally, with longer three row of dense and erect hairs medially and laterally, the hairs curved apically (♂, Fig. 6, MÓCZÁR, 1988: 153). ♀ 3.9-6.8, ♂ 4.6-5.3 mm

deserticola PRIESNER, 1955.

- Head, mesonotum dull, alutaceous, with few shallow and larger punctures especially in vertex. Space moderately convex interiorly, straight at the exterior margin. Propodeum dark ferruginous nearly entirely, posterio-lateral margins and a large spots laterally ivory-yellow. Mesonotum with shallow larger punctures. Mesepisternum rather deeply and sparsely punctured (Fig. 6 Móczár, 1979: 344). Lower margin of last sternite slightly curved in lateral view (Fig. 1, l.c.: 344). Frons with a broad yellow band between eyes. Pronotum with a broad yellowish white posterior margin. Tergites ferruginous, more or less broadly margined behind ivory white. Only middle tibia lined with yellow exteriorly, hind tibiae at most with yellow basal spot. Body with fine silky pubescence. 5-6 mm

opacior PRIESNER, 1955 ♂

Ceropales dubaica MÓCZÁR, ♀ *new*

Ceropales dubaica MÓCZÁR, 1988: Linzer biol. Beitr. 20: 132 ♂

Addition to the description:

♂. - Length 3.8-5.3 mm. Posterior bands of tergites 1-4 continuous, on 5 interrupted medially, tergites 1-2 of two males brownish ferruginous translucent proximally and tergites 1-3 light ferruginous, 4-5 dark brownish black. Frons of all males black medially.

♀ . - Length 3.9-5.9 mm. Similar to male, it differs by some details. E.g. posterior white bands on tergites 1-5 continuous, on 5 not interrupted, tergits 6 nearly entirely white. 2nd antennal joint hardly yellowish, more ferruginous below, labrum pale brownish, not white. lower side of antennal joints largely brownish, mandible brownish ferruginous except the black base. Abdomen especially fore and last sternites, as well as legs, brownish ferruginous.

Head distinctly broader than long (59:54). POL:OOL=9:12. Antenna longer, reaching nearly the end of thorax, all joints longer than breadth, except the 2nd. Pronotal tubercle swelled and elongated below tegula, diameter of thorax here broadler than across tegulae viewed from above. Mesepisternum not so deep punctured as mesonotum. Last segment compressed laterally with a hardly concave or straght margin on its apical half after the declivity, in lateral view.

There are two smaller and two larger female. Three of them collected in the same place and date (Ismailia), one in Wadi Haghoul (in the Eastern desert running more or less parallel to the Red Sea, about 50 km inland, scarce vegetation on the dry river bed, according to A. MOCHI). The colouring of the two smaller specimens (Ismailia) partly darker, e.g. tergites 1-2 more or less dark brownish ferruginous translucent, 3-5 brownish black with continuous white bands, and frons black medially. The colour of the third longer female (Ismailia), as well as on the one of Haghoul: tergites 1-5 light ferruginous; the larger spots in ocular sinus connected in the middle and mandible largely yellow, without black basal spot on the third longer female (Ismailia).

Specimens examined: 4♂, 4♀ Egypt: Ismailia 6.V.1992, A. MOCHI, 1♀ (allotype), 1♂ (Coll. A. MOCHI, Rome), 2♀ , 2♂ (Mus. Budapest), 1♂ (Coll. R. WAHIS, Chaudfontaine); Wadi Haghoul 18.V.1992 A. MOCHI, 1♀ (Coll. A. MOCHI).

Distribution: United Arabian Emirates (holotype Coll. WASBAUER, Calif. Sacramento). First record for Egypt.

Ceropales deserticola PRIESNER, 1955: 1988, MÓCZÁR, Linzer biol. Beitr. 20: 123, 131 ♀ ♂ Figs 5-6. Specimens examined: 11♀ , 12♂. Egypt: Wadi Rayan Fayum 25.V.1991 on Tamariscus A. MOCHI, 5♀ , 6♂ (Coll. A. MOCHI), 5♀ , 4♂ (Mus. Budapest), 1♀ , 1♂ (Coll. R. WAHIS), - Senegal: Ndangane 20.II.1988 A. MOCHI, 1♂ (Mus. Budapest).

Distribution. Egypt. First record for Senegal.

Ceropales grahamstowni MÓCZÁR, 1988: Linzer biol. Beitr. 20: 127, 135 ♀ ♂ Figs 23-24, 28-30. - Specimen examined: Congo = Brazaville, Djoue 23.V.1964 A. MOCHI, 1♂ (Mus. Budapest). - Rep. of South Africa = Transvaal, Klaserie 28-31.XII.1986 leg. MASON, 1♂ (Mus. Alberta). These males partly differ from the diagnosis by the relation of the length of the row of tomentose hairs and the breadth of hind metatarsus. It is rather probable being 2.5:5 (in Congo and Transvaal) than "nearly equals" (in allotype, Coll. TOWNES).

Distribution: Republic of South Africa, Zimbabwe. First record for Congo.

Subgenus **Ceropales** s. str.

THE *VARIEGATA*-GROUP

Ceropales latifasciata ARNOLD, 1937: 1986, MÓCZÁR, Acta Biol. Szeged. 32:126, 135. - Specimen examined: Ethiopia = Harar 4.V.1937 A. MOCHI, 1♀ (Mus. Budapest).

Distribution: Ethiopia, Zaire.

THE *HELVETICA*-GROUP

Ceropales africana MÓCZÁR, 1989: Beitr. Ent. Berlin, 39: 14, 16 ♀ ♂ Figs 1, 11, 19-20, 31-36. - Specimens examined: Congo = Brazaville, Djoue 6.VI.1966 A. MOCHI, 1♂ (Coll. A. MOCHI). - Ivory Coast = Toumodi 21.I.1991 A. MOCHI, 1♂ (Coll. A. MOCHI).

Distribution: West-, Middle- and Sud Africa. First record for Congo.

Ceropales gamblae MÓCZÁR, 1989: Beitr Ent. Berlin, 39: 12, 24 ♀ ♂ Figs 13-14, 44-45. - Specimens examined: Senegal = Thice 18.VII.1991 A. MOCHI, 1♂; Sambadia 10.VII.1991 A. MOCHI, 1♀ , 1♂ and Ndangane 26.VII.1991 A. MOCHI, 1♀ , 1♂ (2♀ , 1♂ Coll. MOCHI and 1♂ Mus. Budapest). - Sudan = Wad Medani 2.VIII.1957 A. MOCHI, 1♂ (Coll. A. MOCHI).

Distribution: West- and Middle Africa. First record for Sudan.

Ceropales kriechbaumeri MAGRETTI, 1984: 1989, MÓCZÁR, Beitr. Ent. Berlin, 39: 15, 34 Figs 2, 5, 12, 26, 56-58. - Specimens examined: Egypt = Keramis 5.V.1970 A. MOCHI, 1♂ (Coll. A. MOCHI); Keranis Fayum 28.IV.1992 A. MOCHI, 1♂ (Mus. Budapest).

Distribution: Upper Volta, Nigéria, Egypt, Israel, Saudi Arabia, Oman, United Arab Emirates, Qatar.

Ceropales variolosa ARNOLD, 1937: 1989, MÓCZÁR, Beitr. Ent. Berlin, 39: 12, 41 Figs 6, 69-71. - Specimens examined: Senegal = Kayar 12.II.1988 A. MOCHI, 2♂; Ndangane 20.II.1988 A. MOCHI, 1♂ and Sambadia 11.VII.1991 A. MOCHI, 2♀ , 1♂ (1♀ , 3♂ Coll. A. MOCHI and 1♀ , 1♂ Mus. Budapest).

Distribution: West- and Middle Africa, Tunisia, Israel, Jordan, Jemen.

Subgenus **Hemiceropales** PRIESNER, 1969

Ceropales cribrata cribrata A. COSTA, 1881: 1986, MÓCZÁR, Acta Zool. Hung. 32: 321, 331 Figs 16-20. - Specimens examined: Italy = La Biodola, Elba Island, Tuscany 20.VIII.1962 A. MOCHI, 1♂ and Capena, Latium 6.IX.1990 A. MOCHI, 1♂ (Coll. A. MOCHI). - Ethiopia = Harar 20.V.1937 A. MOCHI, 1♂ (Mus. Budapest); Asella, Arssi 6.III.1984 A. MOCHI, 1♂ (Coll. A. MOCHI). - Senegal = Tonba - Kouta 12.II.1988 A. MOCHI, 2♀ (Coll. A. MOCHI and Mus. Budapest).

Distribution: South Europe to South Africa and to Kazakh SR in South Asia.

Ceropales maroccana BEAUMONT, 1947: 1986, MÓCZÁR, Acta Zool. Hung. 32: 321, 329 Figs 8-15. - Specimen examined: Tanzania = Zanzibar airport 3.II.1985 A. MOCHI, 1♂ (Coll. A. MOCHI).

Distribution: North- and West Africa, and from Zimbabwe to Caucasus and Turkmen SR.

Ceropales punctulata bulawayoensis BISCHOFF, 1913: 1986, MÓCZÁR, Acta Zool. Hung. 32: 320, 328 Figs 5, 6-7. - Specimens examined: Tanzania = Manyara 24.XI.1972 A. MOCHI, 1♂ (Mus. Budapest); Zanzibar airport 8.VI.1988 A. MOCHI, 1♂ (Coll. A. MOCHI). - Ivory Coast = 40 km S Toumodi 21.I.1991 A. MOCHI, 1♂ (Coll. A. MOCHI).

Distribution: West-, Middle- and South Africa.

References

MÓCZÁR, L. (1986): Revision of the Genus *Hemiceropales* PRIESNER (*Hymenoptera: Ceropalidae*). - Acta Zool. Hung. *32*, 317-341, Figs 1-42.

MÓCZÁR, L. (1986): Revision of the fulvipes-, ruficornis- and variegata-groups of the Genus *Ceropales* LATREILLE (*Hym., Ceropalidae*). - Acta Biol. Szeged. *32*, 121-136, Figs 1-10.

MÓCZÁR, L. (1987): Revision of the maculata and albicincta groups of the Genus *Ceropales* LATREILLE (*Hymenoptera: Ceropalidae*). - Acta Zool. Hung. *33*, 121-156, Figs 1-9.

MÓCZÁR, L. (1988): Revision of the Subgenus *Priesnerius* MÓCZÁR (*Hymenoptera: Ceropalidae*). - Linzer Biol. Beitr. *20*, 119-160, Figs 1-47.

MÓCZÁR, L. (1989): Revision of the helvetica-group of the genus *Ceropales* LATREILLE (*Hym.: Ceropalidae*). - Beitr. Ent. Berlin *39*, 9-61, Figs 1-74.

MÓCZÁR, L. (1990): Revision of the Subgenus *Bifidoceropales* PRIESNER of the genus *Ceropales* LATREILLE (*Hymenoptera: Ceropalidae*). - Acta Zool. Hung. *36*, 59-85.

MÓCZÁR, L. (1991): Supplement to the Revision of the Genus *Ceropales* LATREILLE, I. (*Hymenoptera, Ceropalidae*). Acta Zool. Hung. *37*, 67-74, Figs 1-5.

MÓCZÁR, L. (1993): Supplement to the Revision of the Genus *Ceropales* LATREILLE (*Hymenoptera, Ceropalidae*), II. - Acta Zool. Hung. *39*, in print. Figs 1-17.

ACTA BIOL. SZEGED. 39. pp. 77-91 (1993)

SOIL FAUNA STUDIES IN A BEECH FOREST II. COMPARATIVE STUDIES ON SOIL INVERTEBRATES IN A FOREST, FOREST MARGIN AND A CLEAR-CUT AREA IN HUNGARY

ZS. BOKOR

Department of Ecology, Kossuth Lajos University, H-4010 Debrecen P.O. B. 14. Hungary

(Received: June 1, 1992)

Abstract

In this paper we examined the soil fauna of a beechwood (Bükk Mts.) and the adjacent clear-cut area in northern Hungary during a four-year period from the third year after deforestation. In this research pitfall traps (Barber traps), as well as litter and soil samples were used. Investigations covered the following broad taxa of the soil invertebrate fauna: *Carabidae, Staphylinidae, Arachnoidea, Diplopoda, Chilopoda, Oniscoidea.*

We endeavoured to explore the effects of clear-cutting on the soil fauna, i.e. how it influences population densities, diversity, and the structure of the food chain.

In the clear-cut and the margin the relative abundance of predatory groups (*Arachnoidea, Chilopoda, Formicidae, Carabidae*) was found two times larger than in the forest interior. No significant difference was pointed out in the occurrence of litter decomposers (*Diplopoda, Isopoda*) between the forest and the clear-cut area.

As a result of clear-cutting the abundance of faeces decomposers (*Scarabidae*) declined.

Key words: clear-cut, soil invertebrates, beech forest, soil fauna.

Introduction

In silvicultural practice, mature forest stands are harvested by logging (partial cutting), provided climatic conditions, field morphology and the species' characteristics allow. Where they do not, clear-cutting is employed (DANSZKY, 1973).

Shortly after deforestation the species composition of the soil arthropod fauna will probably alter due to changes in habitat conditions; later it will be rearranged along with secondary succession of vegetation following disturbance. Removal of tree trunks and stumps makes the ground virtually ploughed; the litter and the top soil layers, together with their organisms, are severely disturbed. Secondary succession following deforestation can be traced by consecutive, year-by-year sampling and comparison of clear-cut spots with intact forest stands.

This article examines 17 taxa of the soil arthropod fauna on the "Rejtek" research area. Beyond the number of individuals, abundance and frequency figures relative to the entire soil fauna were considered. Changes in the relative importance of different food-getting strategies and assemblages were compared among the forest, the transitional zone and the clear-cut.

The abundance and diversity, as well as immigration activity of *Carabidae* and *Staphylinidae* were studied by SUSTEK (1984), SZABÓ (1985), IZSVÁK (1984) and HUHTA (1976), comparing forest and clear-cuts. KLEINER (1977) dealt with the same taxa, contrasting populations in a forest and the neighbouring pasture.

WINTER (1987) and SHAEFER (1980) analyzed the density and diversity patterns

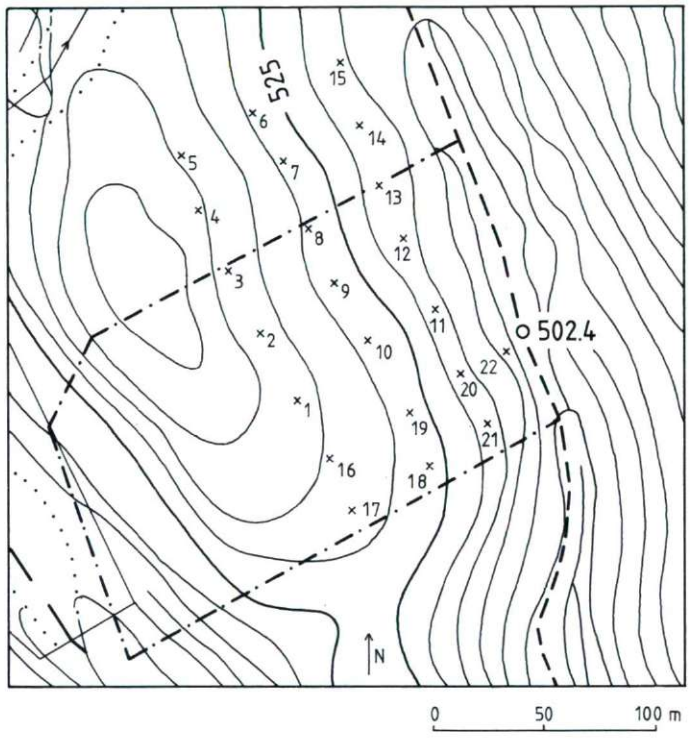


Fig. 1. Location of the sampling area North Hungarian Central Range, Bükk (mountain) Rejtek Projekt

of *Carabidae, Aranei, Opiliones,* and *Pseudoscorpio* after burning of a coniferous wood. The effects of clear-cutting on two of the latter taxa, *Aranei* and *Pseudoscorpionidae* were treated by HUHTA (1976), also including chilopods and staphylinids. In microscopic litter decomposers, different activities were found by SEASTEDT and CROSSLEY (1981), ABBOTT and CROSSLEY (1982) and BLAIR and CROSSLEY (1988). Macrosized litter eaters (*Diplopoda, Oniscoidea*) were studied by SZABÓ (1985) and IZSVÁK (1984), comparing beechwood with clear-cut.

Study area

The 16 ha area is located in Bükk Mts. (part of the Central Hungarian Range), at an altitude of 500 m, with three well-contoured subdivisions: the central plateau, the north-eastern slope (inclination 10-20^0), and the south-western slope (15-20^0). For more details on the area see JAKUCS (1987).

Until the winter of 1980, there had been a 100-120 year old beechwood (*Melico-Fagetum* association) covering the area; in January, 1981, a 4.3 ha spot was deforested by clear-cutting to provide subject for scientific research.

Our studies on the soil fauna started in 1983, the third year after deforestation, with sampling sites positioned on the NE slope, both in clear-cut and the unbroken forest stand.

Sampling method and data analysis

Covered Barber traps, which are a widespread means of sampling soil meso- and microarthropods (LOKSA, 1966; MÜLLER, 1965), were used, while to collect litter and soil samples a 25 by 25 cm square metal frame was applied

The arrangement of sampling sites was determined considerably by topographic and vegetational heterogeneity of the area. Three plots were marked in the forest, the forest edge and the clearcut, respectively. According to our preliminary studies (BOKOR and TÓTHMÉRÉSZ, 1991) these habitats differ significantly and comparisons are well-established by successive sampling. For the four years of the study (1983, 1984, 1985, 1987) permanent traps were set up: there were 6 in the forest, 3 in the margin and 13 in the clearcut (for the arrangement of traps, see Fig. 1.). Samples were taken in every 4 weeks from April to October. From the substancial invertebrate captures the following arthropod taxa were recorded:

Coleoptera: Carabidae, Staphylinidae, Scarabidae
Arachnoidea: Aranei, Opiliones, Pseudoscorpionidae
Chilopoda: Lithobiomorpha, Scendyliomorpha, Geophilimorpha
Diplopoda: Juliformia, Glomeridae, Polydesmidae, Polyxenidae
Isopoda: Oniscoidea
Hymenoptera: Formicidae
Symphyla, Diplura

Summing up the number of individuals per habitat, the frequency of the single taxa relative to the total number of individuals (RFT) was calculated, as well as the relative frequencies in each habitat compared to the same base (RFH). RTF and RFH values are shown in Figs. 3, 4, 5, 6.

Results

The number of specimens altogether captured on the soil surface was 7507 in 1983, 9150 in 1984, 3651 in 1985, and 6192 in 1987 (Table 1.).

Predatory groups are seen to be dominant (40-50%): these are *Carabidae, Staphylinidae, Arachnoidea, Chilopoda, Formicidae*; litter and faeces decomposers (*Isopoda, Diplopoda, Scarabidae*) were represented only with 20-30% and 10-20%, respectively. These figures indicate that less conspicuous, less mobile though abundant arthropod taxa, food for carnivores are under-represented in traps. Individuals of *Polyxenidae, Scendylidae, Geophylidae, Symphyla* and *Diplura* were found almost exclusively in soil samples (Table 2.).

Coleoptera, over and above its remarkable species richness, is considered the most important arthropod taxon in soil (Dunger, 1983)). RFT values for the subject families (*Carabidae, Staphylinidae* and *Scarabidae*), jointly and severally, reached their maximum in the forest, decreasing gradually towards the clear-cut area (Fig. 3.). In the greatest proportion *Scarabidae* spp were sampled, preceding *Carabidae* and the least abundant *Staphylinidae*. The distribution of total *Coleoptera* counts among the three habitats indicates a strong preference for the forest vs. the clearcut or the transitional zone. In comparison with the rest of soil arthropod fauna, percentage of *Carabidae* and *Staphylinidae* appears fairly uniform, whereas that of *Scarabidae* is rather more uneven (Fig. 3.).

The proportion of total *Staphylinidae* counts in the forest increases substancially from the third year after deforestation, meanwhile declines rapidly in the clearcutr and the intermediate zone. Their relative frequency compared to the whole soil fauna (RFT), however, is scarcely higher in the wood than on the other spots.

RFT values for *Scarabidae* decrease from the forest outwards in accordance with the changing division of the global number of mindividuals. Fluctuations in the number of specimens are concordant in the three habitats reflecting the special sensitivity of this group to changes in climatic conditions (particularly rainfall and temperature).

From *Arachnoidea*, the relative abundance of *Aranei* and *Opiliones* is around 10-15% in the clearcut and the forest edge, while in the forest it remains below 10%.

These important carnivorous taxa exhibit year-by-year alternation in relative abundance (Fig. 4.). The density of *Aranei* decreases from the clearcut towards the forest, while the number of individuals is the best-balanced in the forest margin.

Regarding *Opiliones*, habitats differ markedly according to the distribution of total counts: on the average, 40% occurs in the clearcut and the forest edge, albeit in the wood only 10-20% is present.

Pseudoscorpionidae were captured in extremely small amounts; its relative abundance stays below 1% everywhere, distributed almost uniformly among the habitats.

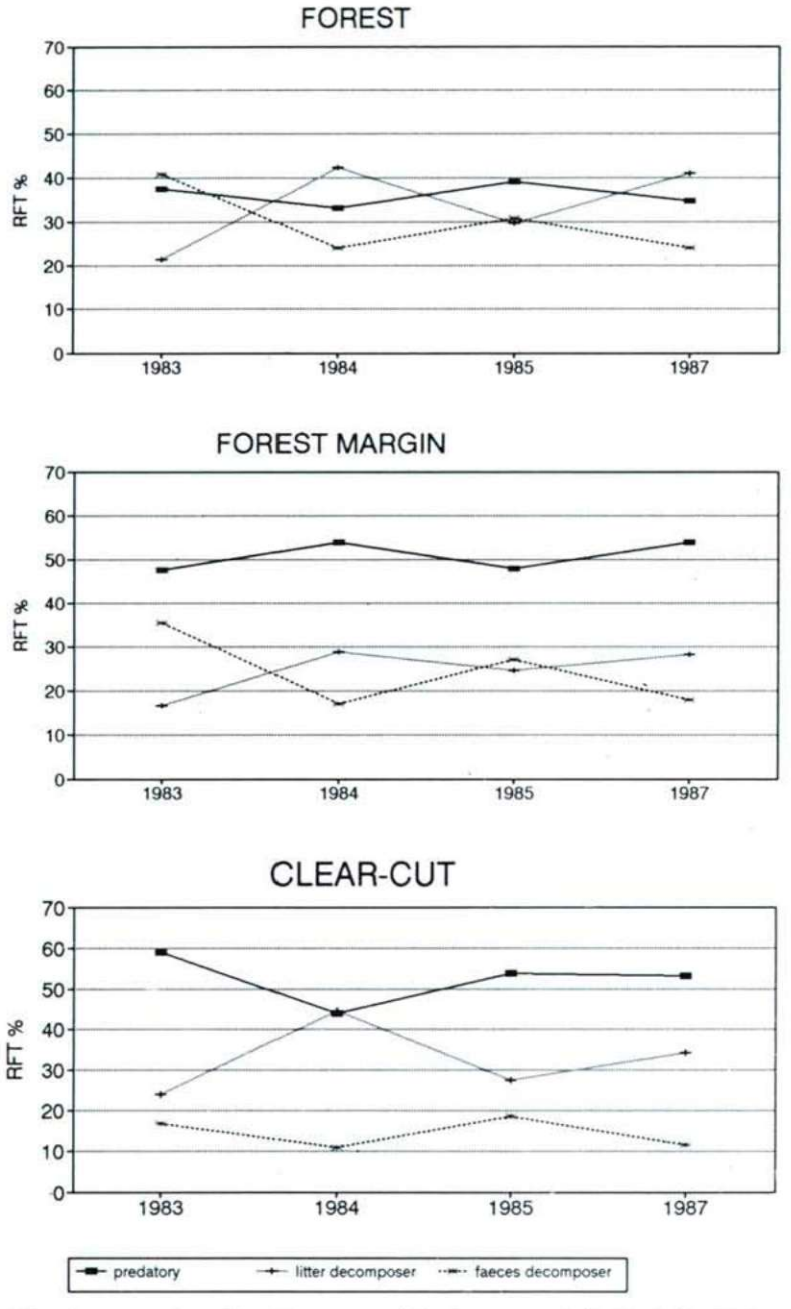


Fig 2. Relative frequency values of predatory groups, litter decomposers in the forest, forest edge and clear-cut area.

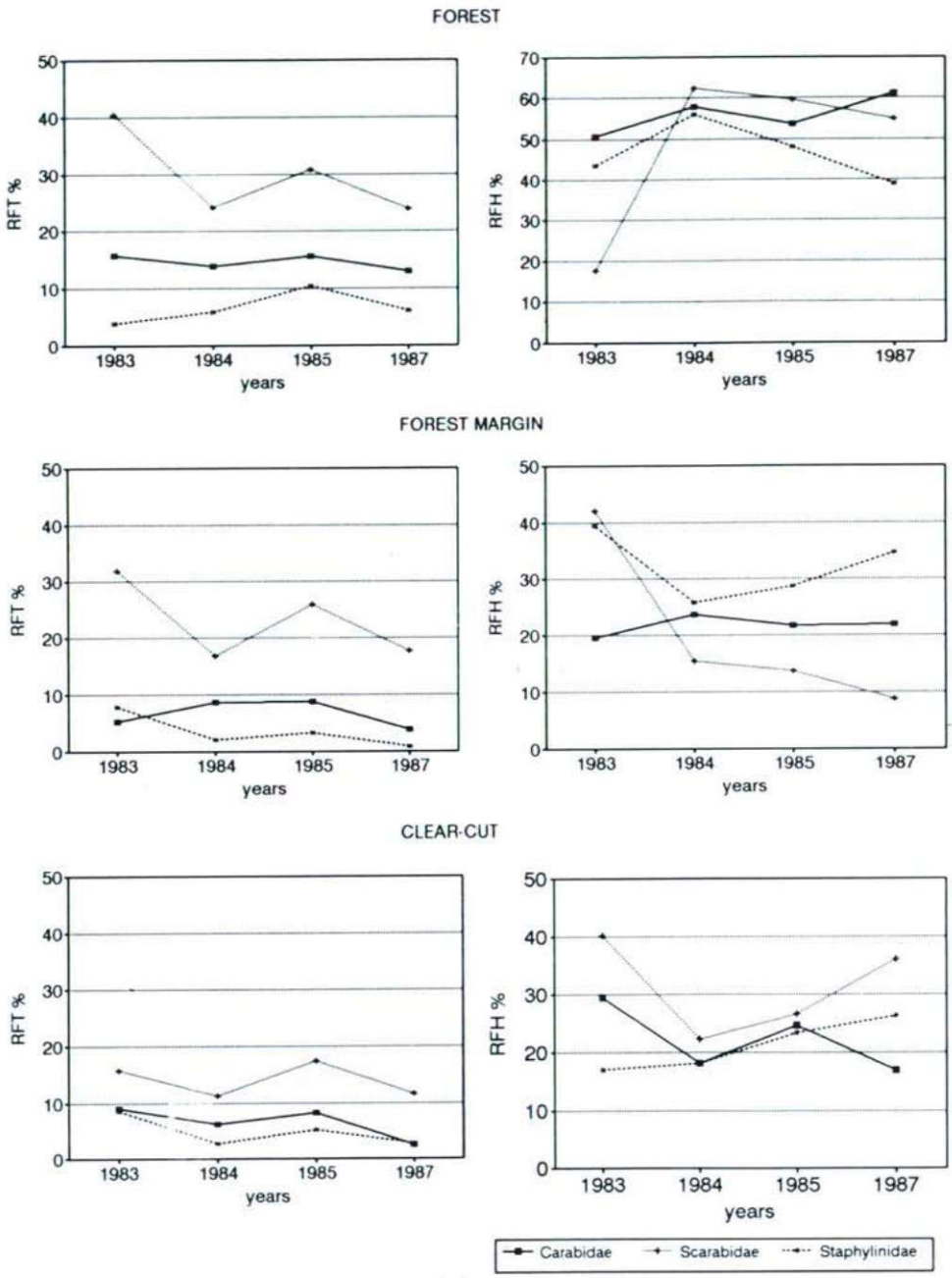


Fig. 3. Relative frequency values of *Carabidae, Staphylinidae* and *Scarabidae* taxa compared to the total number of individuals (RFT) and those of each habitat compared to the base (RFH).

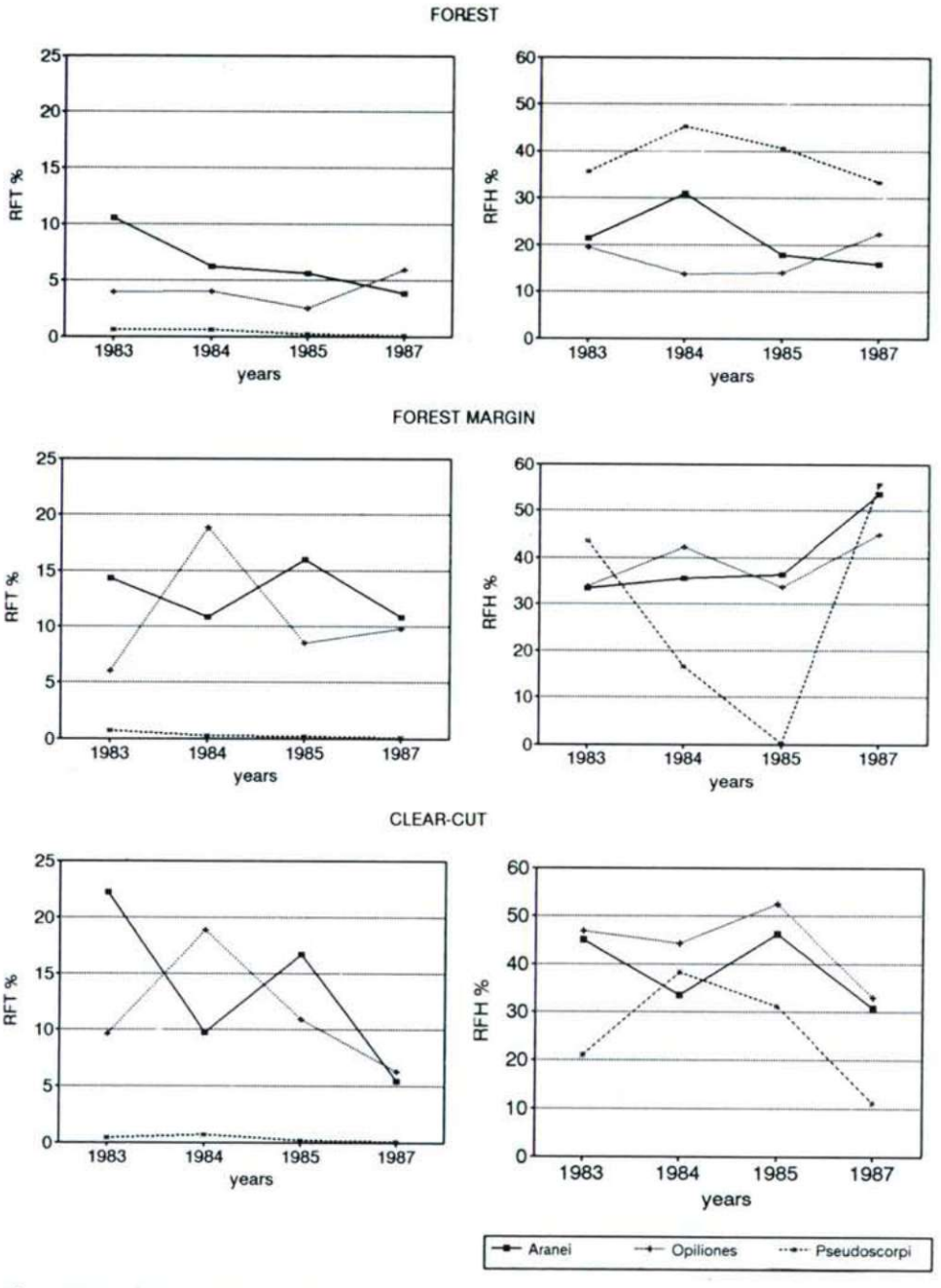


Fig. 4. RFT and RFH values of *Arachnoidea* taxa.

RFT of *Dilopoda*, representative of macrosized litter eaters, hardly exceeds 10-15% during the four years of the study; furthermore this figure comes predominantly from *Juliformia, Glomeridae* and *Polydesmidae*.

Juliformia provide 10% of the total number of individuals at all the three sites, in fairly regular temporal patterns (Fig. 5.).Similar relative frequencies do not imply identical figures of the number of individuals per habitat: the greatest quantities occur in the wood, somewhat less in the clearcut, whilst 20-30% in the intermediate belt. These differences, however, are not considered biologically significant.

The relative frequency of *Glomeridae* is 5-9% in the wood, whereas in the clearcut and the forest margin it is no more than 2-5%. The proportion of total *Glomeridae* counts averages 6-5% in the forest, and 15% in the clearcut and the margin throughout the first three years of the study. However, in the 5th year (the 7th after deforestation) apparent changes began since in the forest decreasing, while outside increasing numbers of individuals were found.

There are very few counts for *Polydesmidae* at every site; consequently, their relative frequency, compared to the whole soil fauna, never exceeds 3%. Interestingly, their abundance peaks in the clearcut in the 3rd and 4th years following disturbance being twice as great as the original score. Later it declines to the level observed in the wood.

The family *Polyxenidae*, represented by a single species, is seen highly infrequent in traps, and even in soil samples it was detected only once in the beechwood in the first year of the study (1983). All these support their presence though do not permit the assessment of their density.

Oniscoidea (terrestrial woodlouse spp.) belongs to the most abundantly represented and most significant litter decomposer taxa. Their relative importance is high with approx. 20%, with yearly fluctuations (Fig. 5.). From the 3rd to the 7th year after deforestation their counts did not remain constant in each habitat either. Their relative abundance (compared to the total soil fauna) is the greatest in the clearcut, followed by the wood and finally the margin; these differences, however, do not imply much significance. The same sequence of habitats can be made according to the distribution of the number of individuals.

Chilopoda were observed to be under-represented by traps; using litter-sooil quadrat blocks considerably larger amounts were caught. Trap captures suggest no significant difference of *Lithobiidae* density between the wood and the clearcut; soil samples, on the contrary, give proof of a higher density in the wood (particularly in the 3rd year after deforestation) than in the clearcut and the intermediate belt. In the following year, however, their numbers increase even in the clearcut, though never approaching those in the wood.

Scendylidae and *Geophylidae*, two other families in question, were detected only in soil samples; their proportions and distributions resemble those of *Lithobiidae* (Table 2. and Fig. 6.).

For *Formicidae* the clear-cut area is highly favourable, since as early as the 3rd year after deforestation greater densities were discerned there than in the margin or the

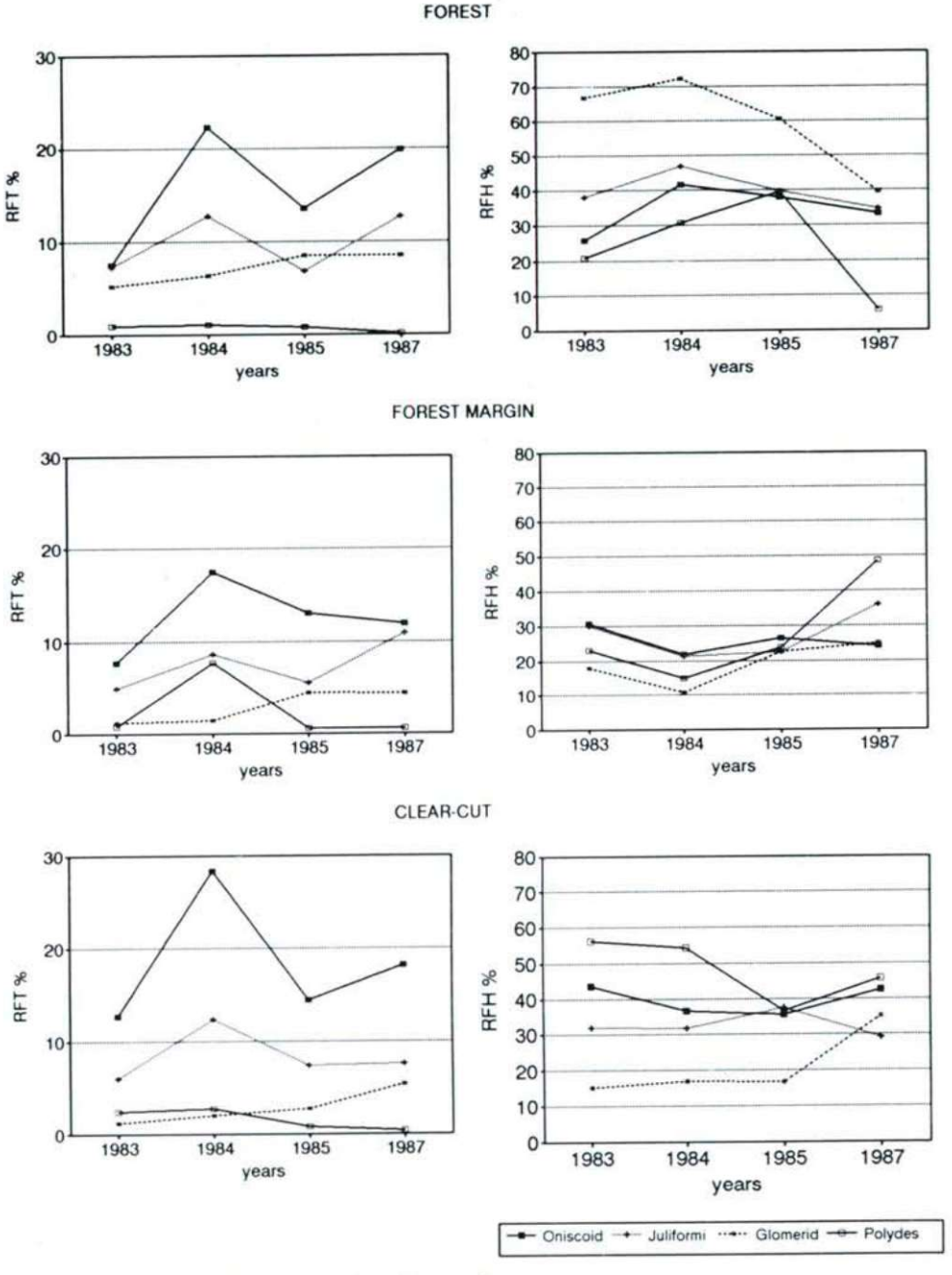


Fig. 5. RFT and RFH values of *Diplopoda* and *Oniscoidea* taxa.

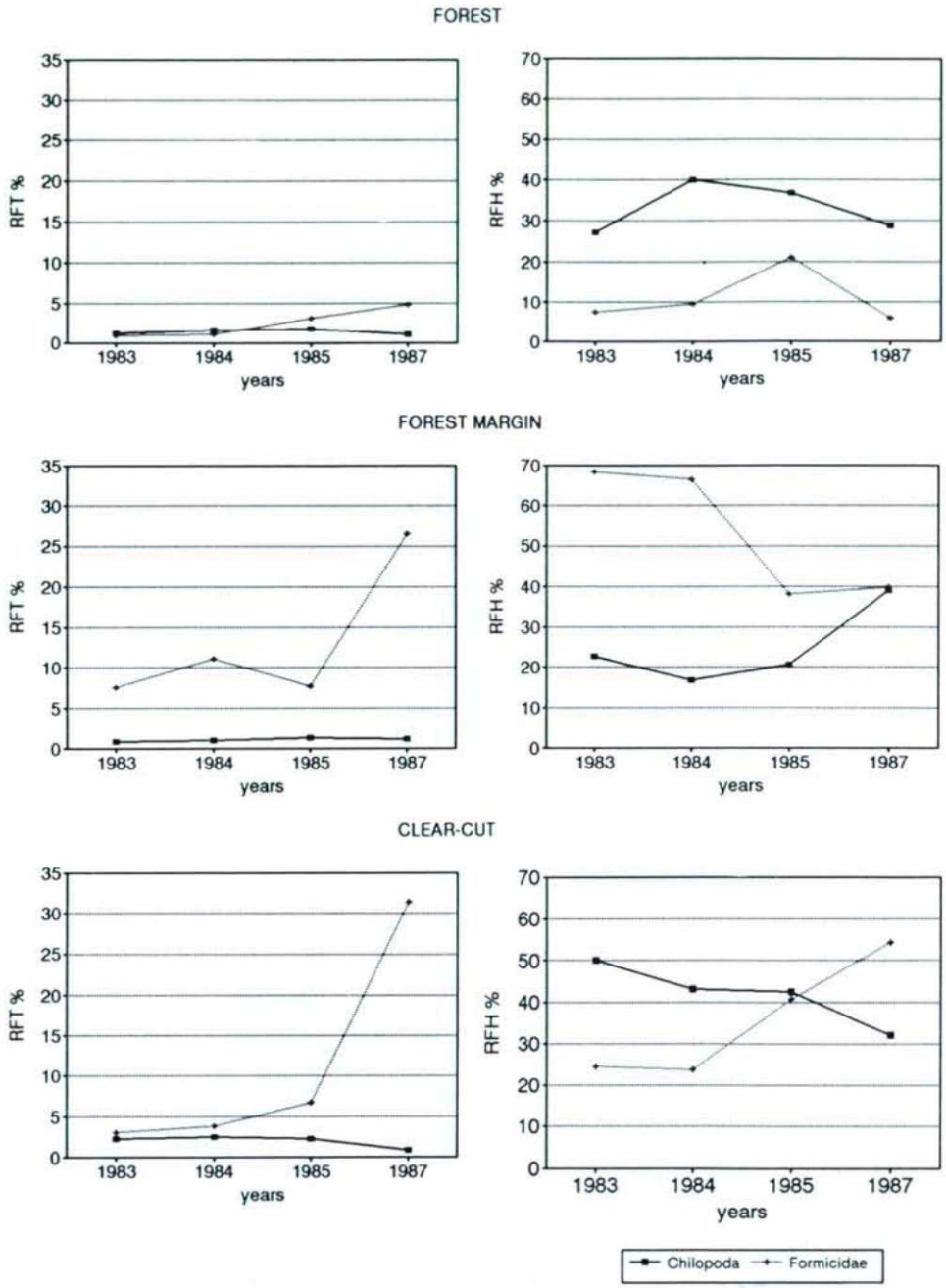


Fig. 6. RFT and RFH values of *Chilopoda* and *Formicidae* taxa.

forest interior (although the former is quantitatively very close to the wood). With time, their numbers rise increasingly, which is also seen in their relative frequenci compared to the whole soil fauna (Fig. 6.).

Other members of the soil arthropod mesofauna, *Symphyla* and *Diplura*, were discovered exclusively in soil samples. The former taxon was found, from the 3rd year after disturbance, in slightly larger quantities in the clearcut than in the other habitats. There was no record of *Diplura* in the clearcut in 1983, but displayed corresponding densities in the three sites the next year.

Table 1. Average number of individuals calculated for one trap per year

count/trap	83.	84.	85.	87.	83.	84.	85.	87.	83.	84.	85.	87.
	clearcut				margin				beech forest			
Carabidae	31	24	40	9	20	32	34	12	52	77	86	33
Scarabidae	53	43	83	41	122	61	102	54	135	132	170	61
Staphylinidae	29	11	25	10	31	8	13	3	13	32	57	16
Aranei	75	37	80	19	55	40	63	33	35	34	31	10
Opiliones	32	72	53	22	23	69	34	30	13	22	14	15
Pseudoscorpionidae	1	3	1	1	3	1	1	1	2	3	1	1
Chilopoda	8	10	11	3	3	4	5	4	4	9	9	3
Juliformia	20	47	36	37	19	32	21	33	24	70	38	32
Glomeridae	4	8	13	19	5	5	18	14	18	35	47	21
Polydesmidae	8	10	4	2	3	3	3	2	3	6	4	1
Isopoda	43	108	70	64	30	64	51	36	8	22	14	20
Formicidae	10	15	33	110	29	41	30	61	3	6	17	12

Table 2. Distribution of taxa examined in soil samples per m^2 during 1983, 1984, 1985 and 1987.

	1983.	1984.	1983.	1984.	1983.	1984.
	beech forest		margin		clearcut	
Pseudoscorpionidae	29	3	3	-	0	19
Juliformia	105	54	56	-	19	45
Glomeridae	4	6	0	-	0	0
Polydesmidae	1	6	6	-	0	13
Polyxenidae	6	0	0	-	0	0
Scendylidae	41	29	16	-	2	48
Geophylidae	28	6	0	-	0	15
Symphyla	25	22	51	-	34	35
Diplura	29	35	21	-	0	29

Discussion

The *Carabidae* and *Staphylinidae* faunas of forested and clear-cut areas were studied by SUSTEK (1984) and KABACIK (1957). The former found lower abundance of carabid and staphylinid beetles in a clearcut than in the adjoining wood. KABACIK, studying *Carabus arvensis*, drew attention to migration between forets and clearcut. CYKOWSKY (1975), comparing forest and meadow, concluded that grasslands maintain less abundant carabid faunas than forests do, although transitional zones are more similar to forested areas in character and have more carabids. KLEINERT (1977) came

to the same conclusion investigating *Staphylinidae*, but in *Carabidae* he found larger abundance on a pasture.

The comparison of the beechwood and the clearcut in my studies at Rejtek also suggests higher relative frequencies of *Carabidae* and *Staphylinidae* in the forest. Consequently, the distribution of the number of individuals among the three localities shows that it is the wood that maintains 50-60% of the entire Carabidae and *Staphylinidae* populations (see Fig. 3.), whereas in the margin and the clearcut only 20% occurs, respectively. The species spectrum, when explored, would no doubt reveal that the species composition of the habitats differs as well as alters, also indicated by the decrease of *Staphylinidae* numbers in the 3rd and 4th year after deforestation, which is succeeded by an accelerating increase later. Presumably, r-strategist species with broader ecologic tolerance spectra are gradually replaced by K-strategists, also demonstrated by WINTER et al. (1983). Larger quantities of *Carabidae* and *Staphylinidae* in the wood certainly result from limited dispersion capabilities imposed by more specialized ecologies rather than food as aresource.

Corresponding surveys on the soil fauna on the "Rejtek" research area were accomplished by SZABÓ (1985) in 1985 and IZSVÁK (1984) in 1983, contrasting beechwood with clearcut. Their results support my observations on *Carabidae* and *Staphylinidae*. Besides the above two taxa, however, they studied Scarabids and big litter decomposers as well.

SZABÓ (1985) found that the proporion of *Scarabidae* relative to the whole soil fauna increased in the clearcut-forest direction five years after deforestation. My results do agree with this, pointing out the wood to support greater abundance of *Scarabidae* than the clearcut and the forest skirt do, namely in each year of the study. It must be noticed, however, that in clearcuts frequently visited by game far denser faeces cover is present than in the forest.

Probably it is the microclimate and exposition of the clearcut that have adverse effects on the expansion of scarabids.

The occurrence patterns of *Oniscoidea* (a group belonging to Isopoda) on the clear-cut area deserve special attention. Their frequency was found higher on the deforested area, albeit they are known to be controlled considerably by Ca^{2+}, pH and humidity (DUNGER, 1983). According to their ecological demands and tolerances, the single families are very diverse as well. What can then account for their slightly greater abundance in the clearcut despite its extreme microclimate? As a plausible explanation, the decreasing pH (acidification) of soil can be considered, described by BODNÁR (1989) and HOLES (1985).

After deforestation, intensive microbial activity leads to higher rates of mineralization of organic matter in soil (SEASTEDT and CROSSLEY, 1981; ABBOTT and CROSSLEY, 1982), which offer *Oniscoidea* favourable environments. As secondary succession proceeds the area becomes increasingly reforested moderating extreme microclimatic conditions. This may explain the similar frequencies and numbers of individuals in the forest and the clearcut in the 7th year after clear-felling.

SZABÓ and IZSVÁK consider clear-cutting an ineffective factor in controlling the abundance of *Diplopoda*. In their studies *Diplopoda* was treated as a homogeneous

group; in my investigations, however, the families *Juliformia, Glomeridae* and *Polydesmidae* were handled as single units, leading to somewhat different results.

Although the total counts of *Juliformia* are unevenly distributed among the three habitats (see Fig. 5.), relative frequency values appear uniform in agreement with the above authors.

Approximately 60-70% of all *Glomeridae* records occurred in the forest, even in the 5th year following deforestation; the rest is divided equally between the clearcut and the forest edge. After this year, howqever, the number of individuals rises notably both in the clearcut and the forest margin, also modifying the relative frequencies (Fig. 5.).

The family *Polydesmidae* is present with small numbers of specimens, showing a slightly decreasing trend in the clearcut. Its relative frequency is constant throughout the thre localities.

Among *Diplopoda, Juliformia* appears the least sensitive of all to changes in microclimate (mainly humidity); or rather, they have evolved an active defence mechanism, i.e. the ability of burrowing to help them survivie extreme microclimates by staying deeper in the soil (DUNGER, 1983). The lack of this capacity necessitates glomerids to exist in litter. Since the soil of the clearcut is rather shallow and full of stones, it offers refuge to the even more hygrophylous *Polydesmidae* spp., which are present there as well as inside the wood, although with extremely low abundances.

The only attending member of *Polyxenidae, P. lagurus* occurs sporadically in soil samples from the forest (Table 2.), but is missing from the clearcut.. Its thin cuticula makes it the most vulnerable of all diplopods and accounts for its sparse occurrence.

WINTER (1987) and SCHAEFER (1988) studied the soil fauna of a burnt-down pine forest from the very first growing season after fire. Winter found that the area was colonized exceptionally fast by *Carabidae*, resulting in great abundance and diversity of r-strategists, which were replaced by K-strategists 2-3 years later.

In *Aranei* and *Opiliones* colonization, basically by immigration, is time-consuming, requiring 2-3 years for *Aranei* to reach the original species number and even more for *Opiliones*. However, species composition will not be the same. Among spiders, surface hunters must be considered in the first place. The effect of disturbance by clear-cutting are less drastic than those after downburning, thus in the third year following clear-felling large abundance characterized the area being twice the original value of the wood. Abounding herbaceous vegetation offers plenty of prey for both carnivorous groups. According to relative frequencies they seem to be antagonists in the clearcut, while in the forest *Opiliones* become out-competed.

In a clearcut made in a mixed pine-deciduous stand, changes in the soil fauna were surveyed by HUHTA (1976), focusing mainly on *Aranei*. Still in the second year after deforestation he found less abundant captures in the clearcut than in the control wood. Moreover, the forest score was not approached until the 5th year. It must be noted,however, that our beechwoods have extremely sparse undersorey vegetation, whereas the above mixed pine-deciduous forests posses more substantial covers. HUHTA showed that *Chilopoda, Thysanura* and *Formicidae* were also less abundant in the second year, and it was just *Collembola* that had more counts in the clearcut at that

time. In chilopods, similar frequencies between the habitats were found five years after disturbance.

My results show that the density of my object chilopod families (*Lithobiidae, Geophylidae, Scendylidae*), according to soil samples, was ten times smaller in the clearcut than in the wood in the 3rd year after deforestation. At the same time, the number of individuals in traps was slightly greater in theclearcut than in the forest. In the next growing season the number of chilopods increased according to both sampling procedures. *Chilopoda* comprises organisms awfully sensitive to changes in environmental factors such as humidity and temperature. Owing to their hidden life history there is some uncertainty in evaluating the confidence of sampling. Exploring species composition will enable a more precise description of their distribution.

According to Huhta (1976) the frequency of *Formicidae* is increased remarkably in the clearcut in 5-8 years and stays high indefinitely. The number of ants in covered traps does not reflect the accurate population densities but provides rough estimates. However, these data allow an approximate picture of *Formicidae* densities for temporal comparisons among the habitats. Obviously, their relative abundance increases in the clearcut and is respectably high in the forest margin, whereas in the wood it remains low albeit increasing. Their overwhelming emigration activity and expansion result from the abundance of food in the first place.

Symphyla and *Diplura* provide a scarce group of the soil fauna, with strange and hidden life histories. In literature they are not treated as distinct categories but as "miscellaneous". These creatures with thin cuticula, sensitive to dehydration, are able to survive in the clearcut finding refuge in soil cavities and cracks as well as under stones; the most favourable conditions, however, were found to be provided by the forest edge.

According to the analysis of these components of the soil mesofauna we can conclude, regarding the various feeding strategies, that the proportion of carnvores increased after clear-cutting, the importance of faeces decomposers decreased, while that of litter decomposers remained nearly unaffected. In the forest margin, the frequency of carnivores is close to that in the clearcut; litter decomposers are seen the least abundant here, whereas faeces decomposers display an intermediate position between forest and clearcut.

References

Abbott, D.t. and Crossley, D.A. Jr. (1982): Woody litter decomposition following cler-cutting. - Ecology, *63*(1), 35-42.

Blair, J.M. and Crossley, D.A. (1988): Litter decomposition, nitrogen dynamics and litter microarthropods in a Southern Appalachian Hardwood forest 8 years following clearcutting. - J. of Applied Ecology, *25*, 683-698.

Bodnár, T. (1989): The effects of clear-cutting on shallow rendzina soils. Bot. Közlem. *76*(1-2), 97-105.

Bokor, Zs. and Tóthmérész, B. (1991): Soil fauna studies in a beech forest I. Comparative study in forest, forest margin and clearcut area in Hungary. - Acta Biol. Debrecina (in print).

CYKOWSKI, R.K. (1975): Dominante auf der Bodenoberfläche der Wiesen und Waldkokote. - Progress in Soil Zoology. Academia publisching House of the Czechoslovak Acad. of Sci. Prague. pp. 183-189.

DANSZKY, I. (1973): Forestry I. - Mezőgazdasági Kiadó, Budapest. pp.923.

DUNGER, W. (1983): Tiere im Boden. - A. Ziemsen Verlag, Lutherstadt. pp. 280.

HOLES, L. (1989): The effects of clear-cutting on soil microbiology in a beech forest (Melitti-Fagetum association). - Ph.D. thesis. pp. 113.

HUHTA, V. (1976): Effects of clear-cutting on numbers, biomass and community respiration of invertebrates. - Ann. Zool. Fennici *13*, 63-80.

IZSVÁK, Zs. (1984): Studies on the soil fauna after clear-cutting. - (ms) pp. 59.

JAKUCS, P. (1987): Ecological research for favourable regeneration of a beech forest coverig shallow soil derived from limestone. - Acta Biol. Debrecina *19*, 5-12.

KABACIK, D. (1957): Zbaden nad biegaczowatymi (Carabidae) lasu sosnavego. - Ekol. Pol. B. *3*, 239-242.

KLEINERT, J. (1977): Soil surface Coleoptera of northeastern Slovakia with regard on family Carabidae. - Biologia (Bratislava) *32*, 307-315.

LOKSA, I. (1966): Die bodenzoozönologischen Verhältnisse der Flaumechen-Buschwälder Südostmitteleuropas. - Akadémiai Kiadó, Budapest. pp. 11-27, 292-299, 365-416.

MÜLLER, G. (1965): Bodenbiologia. - Veb Gustav Fischer Verlag Jene. pp. 324-340.

SCHAEFER, M. (1980): Sukzession von Arthropoden in verbrannten Kiefernforsten II. Spinnen (Araneida) und Weberknechte (Opilionida). - Forswissenschaftliche Centralblatt *99*(5-6), 341-356.

SEASTEDT, T.R. and CROSSLEY, D.A. Jr. (1981): Microarthropod response following cable logging and clear-cutting in the southern Appalachians. - Ecology *62*(1), 126-135.

SUSTEK, Z. (1984): Carabidae and Staphylinidae of two forest reservations and their reaction on surrounding human activity. - Biologia (Bratislava) *39*(2), 137-162.

SZABÓ, L. (1985): The effects of clear-cutting on the arthropod fauna of a beech forest (Rejtek). (ms).

WINTER, K., DÜWEKE, P. and SCHAEFER, M. ((1983): Sukzession von Arthropoden in verbrannten Kiefernforsten der Südheide. - Verhandlungen der Gesellschaft für Ökologie (Mainz 1981) B.X.

ACTA BIOL. SZEGED. 39. pp. 93-100 (1993)

DIE KÖRPERLICHE ENTWICKLUNG VON KINDERN AUS DER GEMEINDE SZEGVÁR (SÜDUNGARN)

GY. L. FARKAS

Lehrstuhl für Anthropologie der József-Attila-Universität

H-6701 Szeged, Pf. 660, Ungarn

(Manuskripteingang: 31. Juli 1993)

Zusammenfassung

Der Autor berichtet über Entwicklungsdaten von Kindern (318 Jungen und 291 Mädchen im Alter von 3,0-14,5 Jahren) der in Südostungarn gelegenen Gemeinde Szegvár (Komitat Csongrád). Die Schlussfolgerungen aus dem im Jahre 1991 beendete Untersuchungen lassen sich wie folgt zusammenfassen:

- der körperliche Entwicklungszustand der erfassten Kinder kann als gut bezeichnet werden;
- die Zahl der als "überentwickelt" (korpulente) zu bezeichnenden Kinder hat im Vergleich zu einer im Jahre 1982 vorgenommenen Analyse merklich zugenommen;
- der Reifezeitpunkt der Mädchen ist im Vergleich zu 1982 um 7-8 Monate vorverlagert.

Schlüsselvörter: ungarische Kinder, körperliche Entwicklung.

Einführung

In der letzten Hälfte dieses Jahrhunderts erfolgten in Ungarn in großem Masse Datenerfassungen bezüglich der körperlichen Entwicklung von Jugendlichen. Zu Beginn der 80-er Jahre waren es im wesentlichen zwei Projekte die zur Standardisierung von Entwicklungsparametern beigetragen haben (EIBEN und PANTÓ, 1986; FARKAS, 1987).

In diesen Studien wurden zu unterschiedlichen Zeitpunkten an Kindern gleicher Siedlungsräume (-gebiete) drei entscheidende Entwicklungsparameter (Körpergröße, Körpergewicht und normaler Brustumfang) mit dem Eintritt des Menarchezeitpunktes vergleichen.

Material und Methode

Das Datenmaterial stammt aus den Jahren 1982 (FARKAS, 1988) und 1991. Beides waren Querschnittsuntersuchungen. Wir ermittelten bei Mädchen den Eintritt der Menarche mittels der "Status-Quo"-Methode. Die Körpermerkmale wurde nach MARTIN bestimmt. Bei der Ermittlung des Lebensalters wurden Dezimalwerte verwendet. Zur Beurteilung der Entwicklungsstadien verwendeten wir die aus dem Jahre 1980 stammenden Normwerte (FARKAS, 1987). Lag das Körpermass unter einem Wert von $\overline{X}$ -1,96.s galt dies als "unterenwickelt", bei Werten von mehr als $\overline{X}$ +1,96.s bewerteten wir dies als "überentwickelt" (überdurchschnittliche Körpergröße , Übergewicht). Die Werte der Körpermerkmale wurden mit dem Stichprobenumfang (n), mit dem arithmetischen Mittelwert ($\overline{X}$), der Steuung (s) und dem beobachteten kleinsten bzw. größten Wert (w) der Halbjahres-Gruppen vergleichen (Tabelle 1-6).

Ergebnisse

Das erste wesentliche Ergebnis war, daß in vergleichbaren Altersgruppen für Jungen bzw. Mädchen im vergleich zu 1982 auch in den Daten für 1991 deutliche Unterschiede auftraten.

In der Untersuchung von 1991 wurden statistische Unterschiede in der Gruppe der 11,5 Jahre alten Mädchen bezüglich der Körpergöße deutlich, bei den 12,5 Jahre alten Mädchen hingegen bei den Werten für das Körpergewicht und im Brustumfang vor allem in Richtung einer Erhöhung dieser Werte. Somit kann aber eigentlich nicht davon gesprochen werden, daß bei den 10 Jahre später Geborenen und altersmässig sowie geschlechtlich vergleichbaren Altersgruppen die körperliche Entwicklung allgemein deutlich weiter war.

In Tabelle 7 wird die Zahl derjenigen dargestellt, die 1982 altersmässig und geschlechtspezifisch unter- bzw. überentwickelt waren. In Tabelle 8 und 9 werden vergleichbare Angaben für die Studie von 1991 aufgezeigt. In Tabelle 7 sind Werte von 9 unterentwickelten Jungen sowie von 1 Mädchen und von 18 überentwickelten Jungen sowie 13 Mädchen aufgelistet.

Nach der Untersuchung von 1991 sind in vergleichbaren Altersgruppen 4 Jungen und 1 Mädchen unter- und 36 Jungen sowie 14 Mädchen überentwickelt. Bei einem Vergleich der absoluten Werte muß jedoch berücksichtig werden, daß es sich bei den Datenerfassungen um Studien mit größenmässig stark unterschiedlichen Stichprobenumfang handelte. Auf der Grundlage der relativen Häufigkeiten zeigt sich somit, daß Adipositas (Überentwicklung) vorrangig bei 10-jährigen auftritt.

Tabelle 10 veranschaulicht aus bei den Datenerfassungen den Eintritt der ersten Regelblutung sowie den zugehörigen Medianwert. Daraus wird ersichtlich wie bei den unter 10 Jahre alten Mädchen der Eintritt der Reife um 0,65 Jahre (d.h. annähernd um 7-8 Monate) verringert wird. Das Gegenteil zeigte sich noch in früheren Untersuchungen aus Ungarn. Die erste Blutung tritt überwiegend im Sommer (Juni-Juli), im Frühjahr (März-April) oder im Winter (Januar) auf (Tabelle 11). Die Saisonalität zeigte sich auch bereits in früheren Untersuchungen aus Ungarn.

Tab. 1. Charakteristische Werte der Körpergröße von Jungen

1982				Lebens-	1991			
n	$\overline{x}$	s	w	jahr	n	$\overline{x}$	s	w
				3	4	98.1	3.56	93-102
				3.5	9	103.1	4.69	95-109
				4	14	103.4	4.25	95-113
				4.5	7	106.0	2.67	102-107
				5	13	110.3	4.21	102-115
				5.5	15	112.9	6.84	99-127
				6	15	116.6	3.62	108-121
				6.5	22	119.5	5.57	109-133
				7	13	122.7	8.45	108-133
				7.5	10	128.7	7.65	114-139
				8	12	129.9	6.83	115-139
				8.5	11	131.5	4.73	125-137
				9	14	135.0	4.90	128-143
				9.5	14	133.3	6.38	124-148
2	142.1	1.98	141-144	10	20	137.3	5.49	126-147
18	141.2	7.88	124-154	10.5	17	141.8	4.63	133-150
15	145.5	6.44	135-157	11	13	142.9	6.60	127-151
24	146.3	8.32	134-166	11.5	14	145.3	6.43	137-162
18	147.5	8.80	131-162	12	19	149.7	9.18	126-171
18	149.3	7.87	139-170	12.5	16	151.6	8.91	132-171
18	152.8	10.30	135-169	13	11	159.7	5.59	152-170
15	154.0	8.76	140-169	13.5	16	159.4	9.49	140-171
9	158.2	10.80	146-175	14	15	161.3	8.47	146-173
3	156.9	13.15	142-166	14.5	4	153.2	5.99	145-158
140					318			

Tab. 2. Charakteristische Werte des Körpergewichts von Jungen

1982				Lebens-	1991			
n	$\overline{x}$	s	w	jahr	n	$\overline{x}$	s	w
				3	4	15.8	1.70	13.7-17.8
				3.5	9	17.7	2.27	13.3-21.4
				4	14	17.8	2.77	14.1-24.6
				4.5	7	18.0	1.06	16.7-19.6
				5	13	20.0	3.60	17.0-30.4
				5.5	15	20.1	3.98	14.9-29.1
				6	15	21.7	2.08	16.2-23.7
				6.5	22	23.3	4.13	16.6-33.5
				7	13	25.9	7.46	16.5-45.5
				7.5	10	27.4	4.76	18.1-36.0
				8	12	31.1	8.38	21.4-48.7
				8.5	11	31.6	7.65	24.3-48.5
				9	14	32.6	5.09	25.2-42.3
				9.5	14	28.1	3.98	23.5-37.1
2	35.3	3.18	33.0-37.5	10	20	34.6	7.11	27.1-48.8
18	35.1	8.53	24.8-60.0	10.5	17	38.6	9.90	29.5-59.7
15	37.9	8.65	27.4-58.4	11	13	38.0	14.90	28.6-61.9
24	39.6	10.05	24.4-69.2	11.5	14	38.4	9.22	27.9-60.0
18	42.8	12.69	28.1-72.8	12	19	41.6	13.40	27.2-86.1
18	42.6	11.76	29.0-72.8	12.5	16	46.2	12.10	27.2-69.7
18	43.1	9.21	30.8-60.6	13	11	46.7	13.20	37.6-80.9
15	43.4	9.46	31.2-70.0	13.5	16	51.4	15.50	32.0-95.2
9	50.2	15.81	34.1-86.1	14	15	53.8	13.10	33.5-75.8
3	46.6	14.97	29.4-56.7	14.5	4	39.3	4.24	36.7-44.0
140					318			

Tab. 3. Charakteristische Werte des normalen Brustumfangs von Jungen

1982				Lebens-	1991			
n	$\bar{x}$	s	w	jahr	n	$\bar{x}$	s	w
				3	4	51.8	1.86	50-54
				3.5	9	53.0	2.85	48-58
				4	14	53.7	3.77	50-66
				4.5	7	53.8	2.05	52-56
				5	13	55.3	4.00	52-67
				5.5	15	54.6	3.71	50-64
				6	15	56.6	2.75	53-61
				6.5	22	58.2	4.21	50-70
				7	13	61.1	6.76	55-80
				7.5	10	61.3	3.70	55-69
				8	12	65.3	9.22	55-85
				8.5	11	65.6	9.89	53-88
				9	14	65.9	4.79	60-78
				9.5	14	62.3	3.37	57-67
2	64.6	5.01	61-70	10	20	68.2	7.60	60-86
18	66.9	6.34	60-87	10.5	17	70.7	8.70	62-89
15	69.1	7.49	60-86	11	13	71.3	9.00	58-92
24	70.5	7.74	62-93	11.5	14	70.4	8.58	65-89
18	74.7	10.63	60-99	12	19	72.0	10.31	63-105
18	72.8	9.97	63-92	12.5	16	75.9	8.79	64-95
18	71.6	5.57	65-82	13	11	72.2	5.76	65-84
15	72.2	6.25	64-88	13.5	16	77.5	10.78	64-107
9	77.2	9.24	68-99	14	15	79.3	8.14	68-98
3	75.0	10.27	63-82	14.5	4	72.2	4.67	67-78
140					318			

Tab. 4. Charakteristische Werte der Körpergröße von Mädchen

1982				Lebens-	1991			
n	$\bar{x}$	s	w	jahr	n	$\bar{x}$	s	w
				3	3	97.0	3.38	94-101
				3.5	13	96.9	3.90	90-104
				4	14	104.3	6.16	97-118
				4.5	10	105.2	5.29	95-116
				5	6	112.2	2.72	107-116
				5.5	17	112.2	5.58	104-122
				6	9	116.5	5.90	105-125
				6.5	9	121.4	6.06	113-130
				7	18	119.7	4.90	108-130
				7.5	15	122.7	5.98	112-136
				8	14	125.1	6.23	113-138
				8.5	15	129.4	8.31	113-139
				9	9	133.7	8.88	120-152
				9.5	12	137.0	9.18	125-155
3	138.9	3.20	136-143	10	12	139.6	8.38	129-152
15	141.4	7.05	130-157	10.5	19	141.2	6.19	130-152
6	143.7	6.63	134-149	11	8	146.5	5.14	139-153
25	144.8	9.27	128-164	11.5	15	151.3	6.92	140-168
8	149.6	8.60	137-158	12	18	151.7	5.66	139-160
21	153.6	5.76	141-168	12.5	12	157.6	6.26	150-172
17	155.6	7.81	145-170	13	12	155.3	5.83	148-168
27	159.7	5.80	149-173	13.5	17	157.2	4.88	146-165
13	157.0	5.81	148-167	14	12	157.9	8.39	140-169
4	158.2	6.02	153-166	14.5	2	153.8	3.32	151-156
139					291			

Tab. 5. Charakteristische Werte des Körpergewichts von Mädchen

1982				Lebens-	1991			
n	$\bar{x}$	s	w	jahr	n	$\bar{x}$	s	w
				3	3	15.6	2.40	13.8-18.3
				3.5	13	14.3	1.47	12.7-16.7
				4	14	17.5	2.63	14.8-23.8
				4.5	10	18.5	3.39	13.4-25.9
				5	6	20.0	1.25	18.3-21.5
				5.5	17	21.6	4.04	16.3-28.6
				6	9	21.9	4.12	14.4-30.3
				6.5	9	24.5	6.33	19.2-37.3
				7	18	21.8	2.50	18.2-27.9
				7.5	15	24.2	5.55	19.4-38.6
				8	14	24.9	4.62	18.8-36.9
				8.5	15	28.9	8.09	18.4-44.2
				9	9	30.6	9.56	21.8-54.2
				9.5	12	40.4	17.34	22.5-70.7
3	31.1	1.10	30.0-32.2	10	12	34.3	7.04	24.3-47.7
15	34.8	6.29	27.5-50.0	10.5	19	38.0	7.02	27.5-49.1
6	37.9	7.03	24.8-43.0	11	8	36.4	6.32	29.5-48.8
25	36.6	7.81	24.8-53.2	11.5	15	41.5	9.90	30.0-67.1
8	41.1	9.07	28.5-54.4	12	18	46.8	11.68	30.6-79.5
21	47.5	10.48	33.8-84.0	12.5	12	56.0	9.16	44.2-72.6
17	46.3	9.36	32.5-66.1	13	12	46.2	6.69	39.0-57.6
27	50.1	7.10	42.0-72.1	13.5	17	47.1	7.51	35.5-60.9
13	48.1	8.41	35.8-63.0	14	12	48.9	8.53	37.2-67.8
4	52.4	11.83	38.0-66.5	14.5	2	42.8	6.58	38.1-47.4
139					291			

Tab. 6. Charakteristische Werte des normalen Brustumfangs von Mädchen

1982				Lebens-	1991			
n	$\bar{x}$	s	w	jahr	n	$\bar{x}$	s	w
				3	3	51.9	5.42	47-58
				3.5	13	51.8	9.92	46-84
				4	14	51.4	2.82	47-59
				4.5	10	53.9	3.55	48-60
				5	6	54.6	1.59	51-56
				5.5	17	56.3	4.34	50-65
				6	9	56.7	5.15	49-69
				6.5	9	57.6	6.10	52-71
				7	18	56.1	3.38	52-65
				7.5	15	57.7	5.30	50-71
				8	14	58.7	4.86	53-69
				8.5	15	62.1	8.40	52-79
				9	9	62.9	8.66	54-84
				9.5	12	74.5	13.90	55-98
3	61.8	0.76	61-63	10	12	66.4	6.03	57-77
15	66.1	5.71	59-78	10.5	19	71.6	9.64	61-84
6	69.2	5.52	59-76	11	8	67.6	7.53	59-84
25	70.1	10.63	57-96	11.5	15	71.2	8.22	59-87
8	72.2	7.47	62-85	12	18	77.1	9.61	63-101
21	79.1	9.18	65-106	12.5	12	86.6	8.36	76-101
17	76.5	7.16	65-92	13	12	78.1	5.63	70-88
27	80.9	6.63	71-98	13.5	17	80.0	6.92	69-96
13	78.8	6.00	71-92	14	12	79.7	6.61	71-95
4	83.3	6.68	77-93	14.5	2	76.4	3.96	74-79
139					291			

Tab. 7. Die Verteilung von Unter- bzw. Überentwicklung aufgeteilt nach Altrerund Geschlecht für 1982

Unterentwickelt						Lebensjahr	Überentwickelt					
Körper-gewicht		Körper-größe		N. Brust-umfang			Körper-gewicht		Körper-größe		N. Brust-umfang	
J.	M.	J.	M.	J.	M.		J.	M.	J.	M.	J.	M.
-	-	-	-	-	-	10	-	-	-	-	-	-
-	-	2	-	-	-	10.5	1	-	1	1	1	-
-	-	-	-	-	-	11	2	-	1	-	2	-
-	-	-	1	-	-	11.5	-	-	-	1	-	3
-	-	1	-	-	-	12	1	-	-	-	2	-
-	-	-	-	-	-	12.5	1	1	-	1	3	1
-	-	1	-	-	-	13	-	1	-	1	-	-
-	-	2	-	-	-	13.5	1	1	-	1	-	1
-	-	-	-	-	-	14	1	-	-	-	1	-
1	-	1	-	1	-	14.5	-	-	-	-	-	-
1	-	7	1	1	-		7	3	2	5	9	5

Tab. 8. Die Verteilung von Unter- bzw. Überentwicklung aufgeteilt nach Altrer und Geschlecht für 1991

Unterentwickelt						Lebensjahr	Überentwickelt					
Körper-gewicht		Körper-größe		N. Brust-umfang			Körper-gewicht		Körper-größe		N. Brust-umfang	
J.	M.	J.	M.	J.	M.		J.	M.	J.	M.	J.	M.
-	-	-	-	-	-	3	-	-	-	-	-	-
-	-	-	1	1	-	3.5	2	-	1	-	1	1
-	-	-	-	-	-	4	1	1	1	1	1	1
-	-	-	1	-	-	4.5	-	1	-	1	-	1
-	-	-	-	-	-	5	1	-	-	-	1	-
-	-	-	-	1	-	5.5	1	2	1	-	1	1
-	1	-	1	-	1	6	-	1	-	-	-	1
-	-	-	-	1	-	6.5	4	2	1	2	2	1
-	-	1	1	-	-	7	1	-	1	-	1	1
-	-	-	1	-	-	7.5	1	2	2	1	1	1
-	-	1	1	-	-	8	3	1	1	1	2	1
-	1	-	2	1	-	8.5	2	4	-	-	2	3
-	-	-	-	-	-	9	2	1	-	1	1	1
-	-	-	-	-	-	9.5	-	3	1	2	-	4
-	2	2	8	4	1		19	16	9	9	13	17

Tab. 9. Die Verteilung von Unter- bzw. Überentwicklung aufgeteilt nach Altrer und Geschlecht für 1991

Unterentwickelt						Lebensjahr	Überentwickelt					
Körper-gewicht		Körper-größe		N. Brust-umfang			Körper-gewicht		Körper-größe		N. Brust-umfang	
J.	M.	J.	M.	J.	M.		J.	M.	J.	M.	J.	M.
-	-	-	-	-	-	10	3	-	-	-	4	-
-	-	-	-	-	-	10.5	3	-	-	-	4	2
-	-	1	-	-	-	11	2	-	-	-	2	1
-	-	-	-	-	-	11.5	1	1	1	1	1	-
-	-	-	-	-	-	12	1	1	1	-	2	1
-	-	1	-	-	-	12.5	3	3	1	1	2	3
-	-	-	-	-	-	13	1	-	-	-	-	-
-	-	-	-	-	-	13.5	1	-	-	-	1	-
-	-	-	1	-	-	14	1	-	-	-	1	-
-	-	1	-	1	-	14.5	-	-	-	-	-	-
-	-	3	1	1	-		16	5	3	2	17	7

Tab. 10. Das Auftreten der Menstruation nach Altersgruppen

1982			Lebensjahr	1991		
Zusammen	Menstruierende			Zusammen	Menstruierende	
	n	%			n	%
-	-	-	9.5	11	-	-
3	-	-	10	11	-	-
15	-	-	10.5	14	2	14.3
6	-	-	11	12	-	-
27	3	11.1	11.5	20	8	40.0
8	1	12.5	12	11	7	63.6
23	9	39.1	12.5	17	8	47.1
19	6	31.6	13	17	15	88.2
27	16	84.6	13.5	6	6	100.0
13	11	84.6	14	3	3	100.0
3	3	100.0	14.5	-	-	-
2	2	100.0	15	-	-	-
146	51			122	49	

Me = 12.93 Jahr
$\overline{X}$ = 12.18 ± 1.11 Jahr

Me = 12.28 Jahr
$\overline{X}$ = 12.17 ± 1.07 Jahr

Tab. 11. Das monatliche Auftreten der ersten Menstruation (Menarche)

1982		Monat	1991	
n	%		n	%
5	9.8	Januar	5	10.4
-	-	Februar	4	8.3
5	9.8	März	5	10.4
4	7.8	April	5	10.4
3	5.9	Mai	2	4.2
2	3.9	Juni	5	10.4
8	15.7	Juli	10	21.0
8	15.7	August	4	8.3
7	13.7	September	3	6.2
4	7.8	Oktober	2	4.2
3	5.9	November	2	4.2
2	3.9	Dezember	1	2.0
51	99.9		48	100.0

Tab. 12. Menarche bei Mädchen aufgeteilt nach Lebensjahren

1982		Lebensjahr	1991	
n	%		n	%
1	2.0	9	-	-
-	-	9.5	-	-
1	2.0	10	1	2.0
1	2.0	10.5	1	2.0
6	11.8	11	10	21.0
11	21.5	11.5	4	8.3
7	13.7	12	11	22.9
5	9.8	12.5	4	8.3
12	23.5	13	6	12.5
4	7.8	13.5	8	16.7
2	3.9	14	3	6.3
1	2.0	14.5	-	-
51	100.0		48	100.0

Als Hauptergebnisse der Analyse der körperlichen Entwicklung von Kindern aus Szegvár läßt sich auf Grund der Untersuchung von 1991 feststellen, daß mit zunehmender Häufigkeit Überentwicklung auftritt und daß in einem so kleinen Siedlungsgebiet die Umweltbedingungen die körperliche Entwicklung von Mädchen (Reife) vorwiegend in Richtung einer Akzeleration verschieben (Tabelle 12).

Literatur

EIBEN, O., und PANTÓ, E. (1986): The Hungarian National Growth Standards. - Anthrop. Közl. *30*, 5-23.

FARKAS, GY. (1987): Newer parameters of the somatic development of 3-19 years old Hungarian children and teenagers. - Acta Biol. Szeged. *33*, 141-149.

FARKAS, GY. (1988): Thesis of Dissertation for Academic Doctor Degree. Somatic development and age at menarche of 10-18 years old girls of Southern Hungary. - Acta Biol. Szeged. *34*, 187-193.

ACTA BIOL. SZEGED. 39. pp. 101-107. (1993)

INCIDENCE OF CRANIAL NON-METRIC TRAITS IN THE BRONZE AGE SAMPLE OF TÁPÉ-SZÉNTÉGLAÉGETŐ

HORVÁTH, G. and OLÁH, S.

Department of Anthropology, József Attila University, H-6701 Szeged, P.O.B. 660, Hungary

(Received: May 10, 1993)

Abstract

Occurrences of cranial non-metric traits in a bronze age sample from Tápé-Széntéglaégető were examined by the authors. The problem of side and sex differences were also examined. In the pooled sample the most frequent traits are Lambdoid ossicles, Postcondylar foramen patent and Mastoid foramen exsutural. The most rare are Condylar facet double, Maxillary torus and Accessoric mental foramen. It can be concluded, that with the exception of Condylar canal divided, there are no significant side and sex differences in this sample.

Key words: Bronze age, Non-metric trait, Side difference, Sex difference

Introduction

A large cemetery at Tápé-Széntéglaégető was excavated by OTTÓ TROGMAYER (1975) from 1960-66. The anthropological description of the bone material was given by FARKAS and LIPTÁK (1975). From 686 graves 579 are dated from the bronze age by the archeologist.

The aim of this article is to publish data on the occurrence of non-metric traits so much the more because non-metric data from such a large bronze age cemetery in Hungary have not been published yet. Besides, the difference in the occurrence of non-metric traits between the sexes and sides also were examined.

Material and methods

This examination is restricted to some of the non-metric traits occurrence in cranium. The scoring technique is mainly based on the suggestions of BERRY and BERRY (1967), FINNEGAN and FAUST (1974). Traits which were uncertain during the scoring procedure were avoided. For the investigation only 454 crania could be used. Altogether 6 traits with unilateral and 32 with bilateral occurrence (Table 1.) were scored. In

case of bilateral traits for the calculation of frequencies, traits were sampled in the total number of sides. It is the most commonly employed method and also having the advantage of maximizing information from fragmentary skeletons (GREEN et al., 1979; OSSENBERG, 1981). Detailed data on frequencies are given for both sides and sexes. The differences in the frequencies between sexes and sides also were examined. In showing the side and sex differences the chi-squared statistics was used. The $\chi 2$ was considered to be significant at the 5% level. If any expected value was less than five the correction of Yates (cit.: SVÁB, 1973) has been applied.

Table 1. Non-metric traits scored in the sample of Tápé

No.	Traits	No.	Traits
1	Ossicle at bregma	20	Mylohyoid bridge
2	Ossicle at lambda	21	Jugular bridge
3	Sagittal ossicle	22	Accessoric zygomatico-facial foramen
4	Incaic bone	23	Accessoric mental foramen
5	Metopic suture	24	Foramen of Huschke
6	Palatine torus	25	Medial supraorbital foramen
7	Ossicle at asterion	26	Lateral supraorbital foramen
8	Parietal notch bone present	27	Accessoric infraorbital foramen
9	Epipteric bone	28	Spinosus foramen open
10	Coronal ossicle	29	Oval foramen open
11	Lambdoid ossicles	30	Oval foramen divided
12	Occipito-mastoid ossicle	31	Ovale-spinosum commons
13	Bipartite parietal bone	32	Parietal foramen absent
14	Bipartite zygomatic bone	33	Postcondylar foramen patent
15	Sutura mendosa	34	Carotic canal open
16	Squamomastoid suture	35	Condylar canal divided
17	Mastoid foramen exsutural	36	Condylar facet double
18	Fronto-temporal articulation	37	Maxillary torus
19	Pterygospinosus bridge	38	Mandibular torus

Discussion

The trait frequencies in male and female samples are given in Tables 2-4.

The chi-squared values of side and sex differences are shown in Table 5. By this method there is not any significant difference (Table 5.) between the sides neither in male nor in female samples.

Sex difference (Table 5.) is found to be significant only in the case of Condylar canal divided (male predominance).

The frequency data of the pooled sample (males, females and non-adults) are given in Tables 4 and 6. In the pooled sample the most frequent traits are Lambdoid ossicles (94.18%), Postcondylar foramen patent (80.00%) and Mastoid foramen exsutural (71.09%). The rarest are Condylar facet double (0.45%), Maxillary torus (0.47%) and Accessoric mental foramen (0.71%). Traits such as Bipartite parietal bone, Bipartite zygomatic bone, Pterygospinosus bridge, Jugular bridge, Carotic canal open and Mandibular torus do not occur at all.

Table 2. Incidence of non-metric traits in the male sample

Trait	Pooled		Right side		Left side	
	Incidence	Frequency (%)	Incidence	Frequency (%)	Incidence	Frequency (%)
7	5/77	6.49	3/38	7.89	2/39	5.13
8	10/46	21.74	3/22	13.64	7/24	29.17
9	1/11	9.09	1/5	20.00	0/6	0.00
10	13/38	34.21	9/20	45.00	4/18	22.22
11	101/105	96.19	50/53	94.34	51/52	98.08
12	2/47	4.26	2/23	8.70	0/24	0.00
13	0/195	0.00	0/94	0.00	0/101	0.00
14	0/124	0.00	0/63	0.00	0/61	0.00
15	0/156	0.00	0/76	0.00	0/80	0.00
16	11/154	7.14	4/78	5.13	7/76	9.21
17	92/128	71.88	43/63	68.25	49/65	75.38
18	2/19	10.53	1/9	11.11	1/10	10.00
19	0/83	0.00	0/43	0.00	0/40	0.00
20	5/109	4.59	2/52	3.85	3/57	5.26
21	0/7	0.00	0/2	0.00	0/5	0.00
22	26/119	21.85	14/60	23.33	12/59	20.34
23	2/154	1.30	2/80	2.50	0/74	0.00
24	9/149	6.04	3/74	4.05	6/75	8.00
25	36/175	20.57	16/85	18.82	20/90	22.22
26	6/166	3.61	2/80	2.50	4/86	4.65
27	0/26	0.00	0/13	0.00	0/13	0.00
28	16/87	18.39	8/45	17.78	8/42	19.05
29	2/93	2.15	0/46	0.00	2/47	4.26
30	3/93	3.23	0/46	0.00	3/47	6.38
31	1/97	1.03	1/49	2.04	0/48	0.00
32	84/148	56.76	37/72	51.39	47/76	61.84
33	43/51	84.31	22/26	84.62	21/25	84.00
34	0/120	0.00	0/58	0.00	0/62	0.00
35	28/95	29.47	16/50	32.00	12/45	26.67
36	1/71	1.41	1/39	2.56	0/32	0.00
37	1/96	1.04	1/49	2.04	0/47	0.00
38	0/147	0.00	0/72	0.00	0/75	0.00

Table 3. Incidence of non-metric traits in the female sample

Trait	Pooled		Right side		Left side	
	Incidence	Frequency (%)	Incidence	Frequency (%)	Incidence	Frequency (%)
7	6/63	9.52	3/30	10.00	3/33	9.09
8	6/46	13.04	3/21	14.29	3/25	12.00
9	5/11	45.45	4/6	66.67	1/5	20.00
10	17/36	47.22	6/15	40.00	11/21	52.38
11	93/97	95.88	49/52	94.23	44/45	97.78
12	1/44	2.27	0/21	0.00	1/23	4.35
13	0/174	0.00	0/87	0.00	0/87	0.00
14	0/121	0.00	0/58	0.00	0/63	0.00
15	1/133	0.75	1/67	1.49	0/66	0.00
16	15/137	10.95	9/64	14.06	6/73	8.22
17	77/102	75.49	37/50	74.00	40/52	76.92
18	1/16	6.25	0/8	0.00	1/8	12.50
19	0/56	0.00	0/27	0.00	0/29	0.00
20	9/107	8.41	4/49	8.16	5/58	8.62
21	0/13	0.00	0/7	0.00	0/6	0.00
22	17/113	15.04	11/56	19.64	6/57	10.53
23	0/149	0.00	0/74	0.00	0/75	0.00
24	9/113	7.96	5/58	8.62	4/55	7.27
25	32/149	21.48	19/74	25.69	13/75	17.33
26	9/154	5.84	3/78	3.85	6/76	7.89
27	1/28	3.57	0/11	0.00	1/17	5.88
28	15/60	25.00	7/30	23.33	8/30	26.67
29	1/71	1.41	1/34	2.94	0/37	0.00
30	0/71	0.00	0/34	0.00	0/37	0.00
31	0/72	0.00	0/34	0.00	0/38	0.00
32	103/158	65.19	50/79	63.29	53/79	67.09
33	37/54	68.52	16/24	66.67	21/30	70.00
34	0/96	0.00	0/49	0.00	0/47	0.00
35	15/109	13.76	6/51	11.76	9/58	15.52
36	0/94	0.00	0/43	0.00	0/51	0.00
37	0/63	0.00	0/29	0.00	0/34	0.00
38	0/134	0.00	0/67	0.00	0/67	0.00

Table 4. Incidence of unilateral non-metric trais

Trait	Pooled		Male		Female	
	Incidence	Frequency (%)	Incidence	Frequency (%)	Incidence	Frequency (%)
1	1/225	0.44	0/82	0.00	1/83	1.20
2	23/202	11.39	8/77	10.39	10/75	13.33
3	73/98	74.49	26/38	68.42	32/40	80.00
4	0/249	0.00	0/93	0.00	0/86	0.00
5	18/290	6.21	8/105	7.62	5/93	5.38
6	1/95	1.05	0/45	0.00	1/25	4.00

Table 5. Results of the $\chi 2$ statistics

Trait	Between sexes booth sides are pooled		Between sides					
			Pooled		Male		Female	
	$\chi 2$	Yates	$\chi 2$	Yates	$\chi 2$	Yates	$\chi 2$	Yates
1	0.99							
2	0.32							
3	1.37							
4	-							
5	0.40							
6	1.83							
7	0.44		0.54			0.00		0.09
8	1.21		0.26			2.67		0.04
9		2.06		2.42		0.86		0.88
10	1.30		0.03			1.29	0.54	
11	0.01		0.25		1.00		0.77	
12		1.25		0.00		1.52		0.43
13	-		-		-		-	
14	-		-		-		-	
15		0.68		0.00	-			0.49
16	1.29		0.05			1.68	1.19	
17	0.38		0.82		0.81		0.12	
18		1.12		0.07		0.45		0.57
19	-		-		-		-	
20	1.30		0.06			0.66		0.19
21	-		-		-		-	
22	1.78		3.25		0.16		1.84	
23		1.28		0.00		1.21	-	
24	0.37		0.17			1.84		0.01
25	0.04		0.00		0.31		1.54	
26	0.89		1.77			1.34		2.00
27		0.45		1.01	-			0.18
28	0.93		0.05		0.02		0.09	
29		0.88		0.03		1.33		0.61
30		1.58		2.70		2.28	-	
31		0.26		0.41		0.49	-	
32	2.29		1.52		1.65		0.25	
33	3.61		0.01		0.04		0.07	
34	-		-		-		-	
35	7.53*		0.02		0.32		0.32	
36		0.84		0.55		0.33	-	
37		0.18		0.54		0.47	-	
38	-		-		-		-	

* - significant difference at the 5% level

Table 6. Incidence of non-metric traits in the pooled sample

Trait	Pooled		Right side		Left side	
	Incidence	Frequency (%)	Incidence	Frequency (%)	Incidence	Frequency (%)
7	12/167	7.19	7/80	8.75	5/87	5.75
8	17/111	15.32	7/52	13.46	10/59	16.95
9	6/30	20.00	5/14	35.71	1/16	6.25
10	37/89	41.57	17/40	42.50	20/49	40.82
11	259/275	94.18	129/138	93.48	130/137	94.89
12	3/112	2.68	2/55	3.64	1/57	1.75
13	0/502	0.00	0/246	0.00	0/256	0.00
14	0/314	0.00	0/153	0.00	0/161	0.00
15	3/369	0.81	2/183	1.09	1/186	0.54
16	28/396	7.07	14/190	7.37	14/206	6.80
17	209/294	71.09	96/140	68.57	113/154	73.38
18	4/48	8.33	2/21	9.52	2/27	7.41
19	0/185	0.00	0/89	0.00	0/96	0.00
20	16/282	5.67	8/133	6.02	8/149	5.37
21	0/33	0.00	0/15	0.00	0/18	0.00
22	59/297	19.87	35/145	24.14	24/152	15.79
23	3/420	0.71	2/210	0.95	1/210	0.48
24	26/374	6.95	12/187	6.42	14/187	7.49
25	88/440	20.00	43/215	20.00	45/225	20.00
26	20/444	4.50	7/220	3.18	13/224	5.80
27	3/91	3.30	1/41	2.44	2/50	4.00
28	40/188	21.28	20/91	21.98	20/97	20.62
29	5/225	2.22	3/104	2.88	2/121	1.65
30	4/225	1.78	0/104	0.00	4/121	3.31
31	4/234	1.71	3/109	2.75	1/125	0.80
32	240/392	61.22	111/191	58.12	129/201	64.18
33	128/160	80.00	63/79	79.75	65/81	80.25
34	0/312	0.00	0/153	0.00	0/159	0.00
35	51/285	17.89	25/139	17.99	26/146	17.81
36	1/221	0.45	1/108	0.93	0/113	0.00
37	1/212	0.47	1/104	0.96	0/108	0.00
38	0/369	0.00	0/181	0.00	0/188	0.00

References

BERRY, A. C. and BERRY, R. J. (1967): Epigenetic variation in the human cranium. - J. of Anatomy. - *101*, 361-379.

FARKAS, Gy. and LIPTÁK, P. (1975): Anthropologische Auswertung des bronzezeilichen Gräberfelds bei Tápé. -In: TROGMAYER, O. (ed.)Das Bronzezeitliche Gräberfeld bei Tápé . Akadémiai Kiadó, Budapest. pp.268.

FINNEGAN, M. and FAUST, M. A. (1974): Bibliography of human and nonhuman non-metric variation. Research Reports No. 14, Department of Anthropology, University of Massachusetts, Amherst. pp.133.

GREEN, R.F., SUCHEY, J.M. and GOKHALE, D.V. (1979): The statistical treatment of correlated bilateral traits in the analysis of cranial material. - Am. J. of Phys. Anthrop. *50*, 629-634.

OSSENBERG, N. S. (1981): An argument for the use of total side frequencies of bilateral nonmetric skeletal traits in population distance analysis: The regression on symmetry on incidence. - Am J. Phys. Anthrop. *54*, 471-479.

SVÁB, J. (1973): Biometriai módszerek a kutatásban. Mezőgazdasági Kiadó. Budapest. pp. 517.

TROGMAYER, O. (1975): Das Bronzezeitliche Gräberfeld bei Tápé. Akadémiai Kiadó, Budapest. pp.268.

ACTA BIOL. SZEGED. 39. pp. 109-111 (1993)

Short communication

CORRELATION BETWEEN THE SALT-EXTRACTABLE, CELL WALL-BOUND PEROXIDASE ACTIVITIES AND THE ETHYLENE PRODUCTION IN THE PULVINI AND PETIOLES OF PACLOBUTRAZOL-TREATED BEAN PRIMARY LEAVES

I. TARI

Department of Plant Physiology, József Attila University
H-6701 Szeged, P.O.Box 654, Hungary

(Received: April 26, 1993)

Abstract

Paclobutrazol [(2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)pentan-3-ol], a triazole growth retardant increases ethylene production in the secondary pulvinus and stalk of the 14-day-old bean primary leaves but not that of the primary pulvinus. Salt-extractable, cell wall-bound peroxidase activities correlated with the ethylene production of the tissues.

Key words: ethylene production, *Phaseolus vulgaris* L. *cv. Juliska*, primary leaf petiole, pulvini, salt extractable, cell wall-bound peroxidase activity.

Plant growth retardants, the chemicals which induce dwarfism, block the biosynthesis of gibberellins, inhibit ethylene production (SAUERBREY et al., 1987; GROSSMANN, 1990) and increase peroxidase activity (HALEVY, 1963; FRY, 1979; UPADHYAYA et al., 1991) in several systems. A dwarf phenotype of pea with impaired synthesis of gibberellic acid$_1$, the active gibberellin in tall plants, has higher soluble and salt-extractable wall-bound peroxidase activities in the internodes than the slender phenotype which has long and thin internodes (JUPE and SCOTT, 1989). Gibberellic acid is supposed to suppress peroxidase activity in the cell walls and prevents the peroxidase-catalysed coupling of phenols between the cell wall polymers (FRY, 1986). High degree of cross-linking between wall polymers results in tight cell walls incapable for rapid cell expansion. Gibberellic acid also inhibits peroxidase secretion into the apoplast (FRY, 1980). The secreted protein molecules may ionically or covalently bound to the cell wall polymers.

RIDGE and OSBORNE (1970) found that exogenously applied ethylene increased the ionically bound fraction of peroxidases in the walls ot etiolated pea epicotyls and the hormone induced an increase in acidic peroxidase level in the cell wall of Bryonia dioica (BOYER and GASPAR, 1980).

Paclobutrazol [(2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-pentan-3-ol], a triazole growth retardant may inhibit (WANG and STEFFENS, 1985) or increase (NAGY and TARI, 1991) the ethylene production of plant tissues. Paclobutrazol is known to inhibit biosynthesis of gibberellins (GROSSMANN, 1990) but not necessarily reduces the gibberellic acid content in the whole plant (NAGY, personal communication), as it was found in case of other retardants (GROSSMANN et al., 1987; NAGY and TARI, 1987). Therefore, we may not exclude a tissue-specific involvement of ethylene in peroxidase secretion in paclobutrazol treated bean plants.

Table 1. Ethylene production in petiole parts of 14-day-old bean primary leaves treated with 8.5 μM paclobutrazol. Seeds were soaked in 8.5 μM paclobutrazol solution and seedlings were grown in garden mould under controlled conditions. Ethylene was determined by gas chromatography in 2.5 cm^3 samples withdrawn from the gas space above the plant material enclosed in 6 ml tubes after 1 h incubation. (Means SE, n=5)

Tissue	Ethylene production (nl· fresh $weight^{-1}·g^{-1}·h^{-1}$)	
	Control	Treated
secondary pulvinus	0.732±0.046	1.600±0.120
stalk	1.174±0.124	1.958±0.108
primary pulvinus	1.666±0.327	1.659±0.143

Table 2. Salt-extractable, cell wall-bound peroxidase activity in the petiole parts of 14-day-old bean primary leaves treated with 8.5 μM paclobutrazol. Ionically bound peroxidases were extracted with 1 mM NaCl in 66 mM phosphate buffer (pH=6.2) from the pellet of tissue homogenate after the extraction of soluble peroxidases. Peroxidase activity was determined as the maximal initial rate of the increase in absorbance at 470 nm with guaiacol as a substrate by the method of JUPPE and SCOTT (1989). (Means±SE, n=3).

Tissue	Peroxidase activity (Guaiacol oxidized (μM)·$sec^{-1}·FW^{-1}·g^{-1}$)	
	Control	Treated
secondary pulvinus	39.01±0.56	44.25±1.13
stalk	6.95±1.86	14.82±1.73
primary pulvinus	23.46±1.68	24.06±1.07

We found higher ethylene production in the secondary pulvinus and stalk of primary leaves of 14-day-old bean (*Phaseolus vulgaris* L. *cv. Juliska*) treated with 8.5 μM paclobutrazol than in the control but in the first pulvinus there was no enhancement in the ethylene level (Table 1).

Ionically-bound peroxidase activities in the apoplast of the stalk and pulvini were correlated to the ethylene production of the tissues (Table 2). The relationship between ethylene action and peroxidase secretion demands further elucidation.

References

BOYER, N. and GASPAR, TH. (1980): Redistribution cellulaire des peroxidases de la Bryone á la suite d'une irritation tactile et d'un traitment par le lithium. - C. R. Séances Acad. Sci. Paris D *291*, 577-580.

FRY, S. C. (1979): Phenolic components of the primary cell wall and their possible role in the hormonal control of growth. - Planta *146*, 343-354.

FRY, S.C. (1980): Gibberellin-controlled pectinic acid and protein secretion in growing cells. - Phytochemistry *19*, 735-740.

FRY, S. C. (1986): Cross-linking of matrix polymers in the growing cell walls of angiosperms. - Annu. Rev. Plant Physiol. *37*, 165-186.

GROSSMANN, K., KWIATKOWSKI, J., SIEBECKER, H. and JUNG, J. (1987): Regulation of plant morphology by growth retardants. Effects on phytohormone levels in soybean seedlings determined by immunoassays. - Plant Physiol. *84*, 1018-1021.

GROSSMANN, K. (1990): Plant growth retardants as tools in physiological research. - Physiol. Plant. *78*, 640-648.

JUPE, S. C. and SCOTT, I. M. (1989): The slender phenotype of pea: stem growth, peroxidase levels and ethylene responses. - Physiol. Plant. *77*, 59-66.

HALEVY, A. H. (1963): Interaction of growth-retarding compounds and gibberellin and indoleacetic acid oxidase and peroxidase of cucumber seedlings. - Plant Physiol. *38*, 731-737.

NAGY, M. and TARI, I. (1987): Gibberellin and auxin contents and ethylene production in the hypocotyls of green and etiolated bean plants treated with chlorocholine chloride. - Biol. Plant. *29*, 28-33.

NAGY, M., TARI, I. and BUBÁN, T. (1991): Hormonal regulation of root formation in paclobutrazol-treated bean plants. - Biochem. Physiol. Pflanzen *37*, 11-18.

RIDGE, I. and OSBORNE, D. J. (1970): Hydroxyproline and peroxidases in cell walls of *Pisum sativum*: regulation by ethylene. J. Exp. Bot. *21*, 843-856.

SAUERBREY, E., GROSSMANN, K. and JUNG, J. (1987): Influence of growth retardants on the internode elongation and ethylene production of sunflower plant. - Physiol. Plant. *70*, 8-12.

UPADHYAYA, A., DAVIS, T. D. and WALSER, R. H. (1991): Alleviation of sulfur dioxide-induced phytotoxicity in cucumber plants by uniconazole. - Biochem. Physiol. Pflanzen *187*, 59-65.

ACTA BIOL. SZEGED. 39, pp. 113-118. (1993)

Thesis of dissertation for academic doctor's degree

RESEARCH INTO THE BIOCHEMICAL EFFECTS OF XENOBIOTICS ON FISH

J. NEMCSÓK

Department of Biochemistry, József Attila University, H-6701 Szeged, P.O.B. 533, Hungary

Preliminaries

Due to the tremendous development of industry and agriculture, the biosphere has become perceptibly damaged in several respects in recent years. The deleterious processes and their effects on living organisms were first examined by scientists working in certain traditional fields of biology: zoology, botany and ecology. In the 1960 s, chemists, toxicologists and biochemists in the industrially developed countries joined in these scientific investigations by participating in both fundamental and applied research. They introduced the most up to date experimental methods of that time, such as isotope technology, separation technology and the biochemistry of nucleic acids and enzymes. As a result, from the beginning of the 1970s, environment; protecting biochemistry appeared as a virtually new branch of learning in the USA, Canada, the Scandinavian countries and other industrially developed countries (REICHENBACH; KLINKE, 1972; KRISTOFERSSON et al., 1974; OZRETICH et al., 1983; HODSON and HILTON, 1983; LOCK et al., 1983; LOYIWOLA et al., 1983). The fundamental research in this field deals with environment; damaging effects with regard to enzymatic and molecular structures. The applied research utilizes those biochemical processes which, according to the basic research, react in a particular way, or in certain cases specifically as far as the given environment; polluting substances are concerned (biomonitoring).

In modern industrial and agricultural technologies, the use of different chemicals is unavoidable. Various of these compounds can pass into the natural waters during or after their use, and can thereby cause considerable damage to living organisms. The living organisms damaged are mainly those subjects to the accumulation of environment; pollution substances (MCKIM et al., 1970; REICHENBACH; KLINKE, 1972; HORVÁTH and STAMMER, 1979; FERRI and MACHA, 1980; ROJIK et al., 1983; BENEDECZKY et al., 1984) Tissue necrosis is one of the most usual signs of damaged organisms. In the event of tissue necrosis, the enzymes transaminase and lactate dehydrogenase (LDH) pass into the circulation of the damaged organ, and their increased activities in the blood indicate the degree of tissue damage (SCHMIDT and SCHMIDT, 1976; KRISTOFERSSON et al., 1974; NEMCSÓK et al., 1981; NEMCSÓK and BOROSS, 1982). Transaminase (EC 2.6.1.1, EC 2.6.1.2), glutamate dehydrogenase (EC 1.4.1.3), and LDH (EC 1.1.1.27) indicate tissue necrosis and have long been used, mainly to reveal tissue necrosis in human diagnostics (WROBELSKI and LA DUE, 1985;

KRISTOFERSSON et al., 1974; ASZTALOS and NEMCSÓK, 1985). The activity of LDH in the blood plasma indicates the degree of general tissue damage , but its different izoenzyme units allow identification of the target organ (ASZTALOS and NEMCSÓK, 1985). For the identification of necrotized tissue, LDH izoenzyimes are utilized most often (as common general substances) in human diagnostics. In mammals, we can distinguish two enzymes: the M unit, which is characteristic of the skeletal muscle, and the H unit, characteristic of the myocardium. In fish there is an additional unit: the C unit, characteristic of the liver (MARKERT and FAULHABER, 1965; SHAKLE et al., 1973; GOLDBERG, 1965) An alteration in blood sugar concentration is suitable for the measurement of stress in the different organs (WEDEMYER, 1970). The environment; polluting materials cause appreciable damage in the nervous system of fish, e.g. through the cholinergic system. The inhibitor of acetylcholine esterase (AChE; EC 3.1.1.7) is extraordinarily dangerous because this can cause the mass death of fish as a consequence of spastic rigor (NEMCSÓK et al., 1981). Research relating to this enzyme in fish was begun later than in warm-blooded animals, and therefore fewer data are available. The majority of the references concern AChE in the electric organ of the electric eel and the ray. This enzyme has been purified, and its molecular structure and kinetic parameters have been determined (AUGUSTISSON, 1948, 1959 a, b; GAAL et al., 1980).

During their metabolism in the organism, certain compounds result in the production of free radicals. Physicians and chemists played an important role in the recognition of oxygen radicals and in the early studies into their role. Their biochemical significance was recognized in 1969 by MCCORD and FRIDOVICH, who demonstrated the role of superoxide dismutase (SOD) in dismuting superoxide. The enzymes involved in free radical reactions allow accommodation to the aerobic environment, the significance being similar to that of the immune system. SOD (EC 1.15.1.1), catalase (EC 1.11.1.6) and glutathione peroxidase (GP-ase; 1.11.1.9) play central role in the prevention of the damaging effects of free radicals.

At an early stage of environment pollution, it is usual for the intensity of motion of fish to decrease. They swim close to the water surface, slowly and in an uncoordinated way. The enzymes involved in the intensity of motion may have a central role in this, e.g. the Ca^{2+} ATP-ase in the sarcoplasmatic reticulum (ER) membrane system (EC 3.6.1.18). The main protein component in the ER membrane system is the Ca^{2+} transport ATP-ase with a molecular mass of 105 kD, which comprises 85% of the total membrane protein mass (MARTONOSI and BEELER, 1984). This high local concentration of the enzyme made its visualization technically possible with the use of an unmanipulated membrane preparation. To date, little information is available on ER Ca^{2+} ATP-ase in fish muscle, and especially its sensitivity to environmental pollution.

Aims and experimental approaches

With regard to the above-mentioned facts and problems in our Department of Biochemistry we have formed a group which carries out research relating to biochemistry in environment protection. Our aim is to study mainly enzymatic processes that indicate the damaging effects of environmental pollution on fish. We examine enzymes, and apply our introduce enzymological methods that indicate tissue necrosis and a damaged nervous system. Some of the fundamental research involves examination of the biochemical kinetic and structural characteristics of enzymes that can be used for biomonitoring, and the effects of anthropogenic compounds in changing these features.

We have initially concentrated on five major tasks:

1. Measurement of serum transaminase and LDH activity in order to determine the degree of tissue damage.

2. Study of the cholinergic system in order to detect the damaging processes in the nervous system.

3. Characterization of the antioxidative enzymes of fish in order to clarify their role in the elimination of free radicals induced by environmental pollution.

4. Research into the Ca^{2+} ATP-ase in the ER membrane in order to discover possible damaging effects on the biochemical process in the muscle.

5. Cytopathological research of the damaging effects of selected pesticie types with the help of light and electonmicroscopic methods.

In our experiments we used carp (*Cyprinus carpio*), which is a very widespread species in Hungary. In certain cases we compared the results on carp (mixed alimentation) with those on species with a different mode of life (carnivorous and herbivorous species).

We examined the effects of $CuSO_4$ (a known fungicide), methidation (MD); (a known insecticide) and paraquat (PQ); (a known insecticide) on fish via the above parameters. The effects of these three compounds were examined individually and also in combination. In certain cases, we analyzed the effects of the most important ecological factors (O_2 saturation, acidity and change in water temperature) on the toxicity of the pesticides. The changes in the biochemical parameters of the fish as functions of the chemical parameters of the water were then investigated in in-cage natural water experiments in order to forecast the expectable environmental pollution. The aim of all this work was to explain certain environment - damaging effects by means of molecular biochemical methods.

Summary

With the use of an enzyme - diagnostic method developed in 1979, the species - dependent, specific organ - damaging effects of the examined pesticides can be followed.

1. Our research revealed that the proportions of the LDH isoenzimes in the carp heart, the body muscle and the gill are not equal. Thus, $CuSO_4$ can be stated to cause necrosis of the heart and body muscle, causes necrosis of the gill, and MD causes necrosis of the body muscle. The serum transaminase and LDH activities demonstrated the largest degree of tissue necrosis in *Hypophthalmichthys molitrix* after $CuSO_4$ treatment. The tissue necrosis in the carp was moderate, while that in the catfish (carnivorous) was the least among the examined fish species. In certain cases where the three pesticides were used in combination at a sublethal concentration level ($CuSO_4$+MD, $CuSO_4$+PQ, or PQ+MD) the tissue - damaging effects revealed that the results of these treatments were additive. In vivo and vitro experiments with insecticides provided more evidence that compounds used in agriculture can cause damage to the biochemical processes of the organism in many ways, and thus are dangerous to the balance of the aquatic ecosystems. It has been proved that PQ and MD affect the oxygen-dependent pathways of the metabolism of fish through their ability to promote free radical production. Cu^{2+} similarly promotes free radical reactions, and can also increase the SOD activity if the Cu^{2+} concentration is high. The toxic effects evoked in fish by PQ through free radical production was decreased by selenium as antioxidant.

2. Certain ecological factors, either alone or combination with xenobiotics, can cause much damage to the fish organism, as proved by the molecular changes in enzymes. In trout, we found that the increasing acidity and the low O_2 concentration of the natural waters in Hungary enhance the tissue-damaging effect of $CuSO_4$ at a sublethal concentration, and also increases the stress load. A hypoxic environment increased the free radical production in fish. Free radicals are harmful for the whole body of the fish because of their damaging effects on the cell membrane. Our results indicate that high temperature, the ammonia concentration and a low level of O_2 have decisive (or primary) roles in the development of gill necrosis. The pathology of fish swimming bladder disorders caused by inflammation has not been clarified so far. Our results suggest that the elevated free radical and H_2O_2 production (indicated by the increased activity of antioxidative enzymes and increasing lipid peroxidation (LPO)) at the site of the inflammation may play an important part in the emergence of this illness. We found that MD inhibits AChE activity to different extents, depending on the season-dependent changes in water temperature. This permits a more exact forecast of how much damage the water temperature-dependent accumulation and metabolism of MD can cause to the nervous system of fish.

3. Our results demonstrated a close relation between the quantity of acetylcholine (ACh) and the activity of choline acetyl transferase (ChAT) in the brain of the examined species of fish. There is no connection between the AChE activity, the quantity of

ACh and the ChAT activity. This supports the observation that the ChAT activity is more characteristic of the cholinergic system than is the activity of AChE (CONTESTABILE, 1978). On the basis of the ChAT activities measured in the brain, three different groups can be established. The first group consist of the species with the highest ChAT activity, all these species having excellent visual orientation. They are those carnivorous fish species whose eyesight is of primary importance in the acquisition of food. For the carp, belonging in the second group, eyesight is only of secondary importance. The catfish and Ictalurus nebulosus, which belong in the third group, detect their food by touch. These data reinforce the supposition that the activity of ChAT in the fish brain is close by connected with the state of development of the eyesight, which depends on the mode of life of the fish (carnivorous or herbivorous).The activity of the ChAT in the trunk muscles (primarily involving cholinergic innervation) is highest in carp and trout. This can be explained in that these species move continuously while searching for food. The ChAT activity in the trunk muscle of carnivorous fish is relatively low, which means a reduced cholinergic innervation. The food acquisition of carnivorous fish is characterized by little movement. These fish usually lie in ambush, and the capture of the prey needs only a sudden short movement.

The isoelectric point of carp brain ChAT the Km values demonstrates that ChAT is a conservative enzyme: perhaps because of its important role in the organism, its basic biochemical features have not changed during millions of years, even in species far from each other phylogenetically.

The results of radioligand type binding experiments led to the first description of the predominance of the receptor types in the carp brain, as evidence of the ancient character and phylogenetic inferiority of the carp brain in comparison with the brain of mammals. Further evidence of this is the extraordinarily high proportion of the molecular subform A1, 2 of AChE.

4. There are differences in the distributions of SOD, catalase and GP-ase activity among the various organs, and the degree of LPO is not identical in different species of fish. This signals an existing connection between the extent of free radical reactions and the differences in their modes of life. This is connected with their metabolism, which evokes an accelerated growth in weight. The activities of antioxidative enzymes also increased, which means that the organism is not fully protected against LPO processes, even under normal physiological conditions. Membrane damage of little significance can occur constantly. This reinforces the role of free radicals in aging processes: in old age, not only do the activities of the enzymes of the immune system decline, but the repair processes deteriorate too. Damage to membranes and proteins of vital importance and nucleic acids can therefore cause disorder in the physiological functions.

5. Biochemical examination of SR Ca^{2+} ATP-ase demonstrates significant differences in the functional role of several segments of this enzyme and in their positions in the molecule in comparison with the similar enzymes of mammals. The examined pesticides inhibited the Ca^{2+} ATP-ase of carp specifically. It can therefore be supposed that various pesticides in sublethal concentrations decrease the intensity of motion-dependent reactions in connection with the acquisition of food and escape through inhibition of ER Ca^{2+} ATP-ase.

Results for utilization

1. The chosen biochemical parameters are suitable for the complex examination of the damage caused to fish populations by different chemical substances of agricultural and industrial origin.

2. Our methods are suitable for determination of the degree of danger that can result in the fish body in consequence of pollution.

3. Certain harmful biochemical and histological changes can be detected, as in the case of the mass death of eels in Lake Balaton in 1991.

ACTA BIOL. SZEGED. 39, PP.119-124. (1993)

MALADIES, ACTIVITÉS ET ENVIRONNEMENTS DES POPULATIONS ANCIENNES EN EUROPE CENTRALE ET OCCIDENTALE: APPROCHE DE PALEOPATHOLOGIE COMPAREE

Thèse de Doctorat Nouveau Régime soutenue à l'Université de Provence (Aix-en-Provence, France)

GY. PÁLFI

Département d'Anthropologie à l'Université József Attila, H-6701 Szeged, P.O.B. 660, Hungary;
Laboratoire d'Anthropologie et de Préhistoire des Pays de la Méditerranée Occidentale,
Université de Provence, 29, av. R. Schuman, 13621 Aix-en-Provence, France.

Introduction

Ce mémoire est une tentative de reconstitution de certaines conditions paléo-écologiques de différentes populations anciennes d'Europe Centrale et Occidentale. Il regroupe les résultats de recherches paléopathologiques effectuées au cours des trois dernières années.

Depuis1989, nous avons poursui nos recherches dans le cadre de la formation doctorale du Comité de Qualification Scientifique de l'Académie des Sciences de Hongrie. Ces recherches ont lieu au Département d'Anthropologie de l'Université József Attila et leur but consistait à réaliser une analyse comparative des lésions paléopathologiques ostéo-articulaires découvertes dans différentes séries ostéoarchéologiques historiques hongroises. Ces études ont été dirigées par le Professeur Gyula Farkas et notre consultante scientifique a été Antónia Marcsik, chargé de cours à l'Université József Attila. Nos recherches en France se sont déroulées pendant les deux années universitaires 1991-1992 et 1992-1993 dans le cadre d'un doctorat de l'Université de Provence placé sous la direction du Docteur Olivier Dutour, Chargé de Recherche au CNRS, avec les soutiens du Ministère des Affaires Etrangères français et de la Fondation Fyssen (Paris). Notre tuteur français a été rejoint par le Professeur Gyula Farkas, directeur du Département d'Anthropologie à l'Université József Attila (Szeged).

Matériel et Méthodes

Nous avons limité ce travail à la présentation et à l'interprétation des pathologies ostéo-articulaires relevées sur un effectif total de 355 squelettes, provenant de deux régions géographiques différentes : le Sud-Est de la France pour la partie occidentale et l'Est de la Hongrie pour l'Europe Centrale. Une étude

paléopathologique comparée a été effectuée afin d'évaluer les tendances principales de l'état sanitaire et du mode de vie de ces deux populations.

Quatre-vingt-douze squelettes provenant de fouilles archéologiques dans le Département du Var (conservés dans les collections du Centre Archéologique du Var, Toulon) représentent la partie française de notre étude. A l'exception d'un squelette médiéval, tous les squelettes peuvent être datés de l'Antiquité tardive, la fourchette chronologique étant assez large (300 ans environ). L'unité relative des nécropoles en question et le recoupement manifeste des occupations nous a permis de réunir 91 squelettes sous le terme de "groupe des séries gallo-romaines" et de nous en servir comme d'une "population", avec toutes les réserves d'usage, au cours de l'étude comparative. La série hongroise de Sárrétudvari représente un ensemble de squelettes plus important (263 squelettes; collections du Département d'Anthropologie de l'Université József Attila, Szeged), qui correspond mieux à la définition stricte du terme "population", étant donné l'utilisation courte et bien déterminée de la nécropole.

L'état de conservation des squelettes est nettement supérieur dans la série hongroise. Les données d'ordre paléodémographique dans les deux groupes (Groupe des séries gallo-romaines et Sárrétudvari : répartitions des sujets adultes-subadultes, répartitions des tranches d'âges et des sexes dans les groupes adultes, proportions des adultes, proportions des adultes d'âge indéterminé) ne diffèrent pas significativement.

L'examen des pièces pathologiques a fait appel à l'observation macroscopique parfois relayée par la microscopie binoculaire. Dans les cas plus difficiles, nous avons établi le diagnostic différentiel à l'aide des examens radiologiques et d'une analyse ostéo-densitométrique. Le diagnostic a été fondé sur les données actuelles de sémiologie anatomo-clinique et radiologique en gardant à l'esprit le fréquent manque de spécificité des signes observés sur l'os sec. Dans tous les cas où l'effectif l'a autorisé (cas ou sujets pathologiques, localisations des lésions observées) nous avons contrôlé nos résultats à l'aide de méthodes statistiques.

Résultats et discussion

L'analyse a relevé une très riche pathologie dans les deux groupes. En réunissant les lésions selon les cadres nosologiques, des signes osseux de 575 processus pathologiques ont été observés sur 147 squelettes atteints. Nous avons essayé, dans la mesure du possible, de présenter les cas observés sous forme d'études synthétiques. Une étude plus détaillée a été donnée dans certains cas particulièrement importants, présentant chaque fois des exemples de la méthodologie et des difficultés de nos approches diagnostiques. Au cours du dépistage systématique des altérations pathologiques, classées selon leurs étiologies probables, nous avons comparé leurs distributions dans le groupe gallo-romain et dans la série de Sárrétudvari, les répartitions à l'intérieur des populations, selon l'âge et le sexe des individus.

La distribution des pathologies présente une ressemblance très remarquable dans les deux groupes. Quatre groupes nosologiques sont les plus fréquents, aussi bien dans le matériel osseux provençal que dans la série hongroise : les traumatismes, l'arthrose périphérique et vertébrale, et les enthésopathies mécaniques.

1) En ce qui concerne les traumatismes, ce sont les fractures consolidées dont les traces ont été relevées le plus fréquemment. Leur taux, presque identique dans les deux groupes, présentent chaque fois une prédominance masculine hautement significative. Les entorses graves sont des atteintes exclusivement retrouvées sur les sujets masculins

de Sárrétudvari. Les trépanations relevées dans la série de Sárretudvari indiquent que ces coutumes païennes sont encore vivantes au Xe siècle en Hongrie. Outre leurs intérêt ostéoarchéologique, elles fournissent des informations socio-culturelles et médico-historiques.

2) Les arthroses périphériques sont fréquemment relevées dans les deux populations, mais ne prédominent chez l'homme que dans la série de Sárrétudvari; les femmes gallo-romaines semblent être plus fréquemment atteintes que les femmes hongroises (cette tendance s'observe encore, bien qu'elle soit moins nette, au niveau des enthésopathies mécaniques). La répartition sexuelle des arthroses vertébrales, pathologie généralement fréquente, est plus homogène. Les localisations présentent cependant une distribution différente dans les deux groupes, du fait de la fréquence plus élevée de la cervicarthrose dans la population gallo-romaine. Les enthésopathies mécaniques prédominent chez l'homme, plus nettement dans la série de Sárrétudvari.

3) Les signes osseux et ostéoarticulaires des infections s'observent le plus souvent sous la forme d'ostéites aspécifiques, et entrainent de grandes difficultés diagnostiques (par exemple les périostoses généralisées dans 4 cas gallo-romains). Les cas d'infections spécifiques sont plus sporadiques. Les pathologies plus rares apportent moins d'informations pour la paléopathologie comparative, mais fournissent des données diagnostiques importantes (par exemple certains cas d'ostéonécroses aseptiques ou d'ostéodystrophies de croissance dans la série de Sárrétudvari) ou paléoépidémiologiques (arthropathies inflammatoires).

4) Dans le chapitre dernier nous avons réuni des marqueurs squelettiques attribuables aux effets environnementaux. En ce qui concerne les marqueurs squelettiques d'activité, les macrotraumatismes indiquent dans certains cas des blessures de combat (lésions crâniennes (Gréoux, Sárrétudvari) ou les fractures de "défense" ("Parry-fracture") (Sárrétudvari). Plusieurs cas d'arthrose secondaire peuvent être considérés comme des marqueurs articulaires d'activité (notamment les arthroses du coude et du poignet, le plus fréquemment relevées chez les sujets masculins de Sárrétudvari), mais l'absence de spécificité des lésions nous empêche souvent de préciser l'activité exacte.

5) Les enthésopathies mécaniques, en général, nous renseignent mieux sur les activités en cause mais, avant de les attribuer au surmenage musculaire, il est indispensable d'examiner soigneusement tout le reste du squelette pour éviter une confusion éventuelle avec un processus hyperostosique. Deux sujets masculins de Solliès-Toucas et plusieurs de la série hongroise présentent des enthésopathies unilatérales au niveau des os des avant-bras, dues à une hypersollicitation du coude. Ces altérations doivent être interprétées en fonction du contexte archéologique. La forte prédominance masculine et l'unilatéralité fréquente des cas d'enthésopathies sous forme de dépression au niveau des humérus et les clavicules semblent indiquer qu'ils sont la marque d'hypersollicitations musculaires. Les signes d'hypersollicitation para-articulaires du pied (exostoses antérieures et surtout le "syndrome de la queue de l'astragale"), s'observent plus fréquemment chez les sujets masculins, dans la série hongroise en particulier.

6) L'affection la plus clairement interprétable reste cependant les enthésopathies multiples s'observant au niveau des os du bassin et des fémurs, l'ensemble lésionnel du "syndrome du cavalier", relevé sur 14 squelettes masculins de Sárrétudvari. En considérant certaines enthésopathies comme séquelles probables d'une hypersollicitation du coude par flexions répétées, nous arrivons à reconstituer l'activité classique du guerrier hongrois du Xème siècle: celui du cavalier-archer.

Conclusions

Il est évident que dans le cas de séries bien documentées, l'apport de l'interprétation archéologique contribue efficacement à reconstituer certaines activités dominantes décelées par l'étude paléopathologique. L'intérêt de telles enquêtes paléopathologiques réside essentiellement dans la modélisation de certains marqueurs squelettiques d'activité.

D'autres marqueurs paléoenvironnementaux, comme ceux de la malnutrition, des anémies ou du stress sont plus modestes dans notre matériel examiné. L'hyperostose spongieuse du crâne s'observe plus fréquemment chez les sujets subadultes dans la série de Sárrétudvari. Dans les cas adultes, nous avons constaté, de façon comparable à celle de l'hypoplasie de l'émail, l'association de ces lésions aux processus infectieux généralisés du squelette.

Une étude détaillée de certains cas individuels a été présentée dans notre étude, notamment ceux qui sont les témoins de maladies infectieuses : en effet, ces "cas" en apparence isolés, fournissent d'importantes données d'ordre épidémiologique pour l'ensemble d'une région à une période donnée. Le premier, en importance, est la découverte, le diagnostic et l'interprétation du cas de syphilis congénitale précoce provenant de la série de Costebelle. Ce cas, comme nous l'avons indiqué, est une des rares preuves de l'existence ancienne de la tréponématose vénérienne en Europe et on le considère comme un argument à l'encontre "du dogme" post-colombien. L'importance du cas portant des stigmates osseux d'une spondylodiscite d'origine tuberculeuse provenant de la tombe médiévale de la Roquebrussanne, réside essentiellement dans la rareté des observations de ce genre dans la région au Moyen-Age. Notons que le bon état de conservation a permis de reconnaître une altération souvent restée inaperçue des paléopathologistes : les appositions ostéopériostées liées à la présence d'un abcès froid tuberculeux. Une autre atteinte d'origine mycobactérienne a été identifiée dans la série de Sárrétudvari : la lèpre. Il s'agit de la première apparition de la maladie dans le matériel ostéoarchéologique du Bassin des Carpathes.

Bien que l'effectif de ces séries ne soit pas très élevé, leur richesse en pathologie ostéoarticulaire nous a permis d'effectuer un examen paléopathologique fournissant une série de données pleines d'intérêt. Pour certaines d'entre elles, dans les cas de pathologies fréquentes surtout, les proportions sont statistiquement comparables. Il en reste d'autres, où les tendances ne sont pas aisément interprétables. Nous avons pu constater, par exemple, des différences importantes au niveau de la distribution des

enthésopathies mécaniques, mais les effectifs très réduits ont empêché leur examen statistique. Des études systématiques d'autres séries osseuses historiques humaines pourrait améliorer la compréhension de la paléoépidémiologie des maladies infectieuses ou rhumatismales. En ce qui concerne les marqueurs squelettiques d'activité, il convient d'examiner de larges séries ostéoarchéologiques anciennes et plus récentes, archéologiquement et historiquement bien documentées, afin de pouvoir établir un modèle méthodologique convenable.

Malgré l'ampleur relativement réduite de cet effectif et les différences chronologiques et topographiques des séries qui ont rendu l'étude comparative parfois difficile, nous espérons que ce travail pourra contribuer à une meilleure connaissance de la paléoécologie des populations anciennes en Europe Centrale et Occidentale.

Liste des publications relatives au sujet de la Thèse

Publications parues:

BÉRATO, J., DUTOUR, O. et PÁLFI, GY. (1991): A propos d'une spondylodiscite médievale du Xème siècle (La Roquebrussanne, Var, France). - Paléobios 7, 1, 9-17.

DUTOUR, O., PÁLFI, GY. et BÉRATO, J (1991): Lésions ostéopériostées chez un foetus du IVème siècle de notre ère. - Revue de Rhumatisme 58/10, 693.

MARCSIK, A. et PÁLFI, Gy. (1992): Differential diagnostic problems of tuberculosis in skeletal material. - MUNIBE (Antropologia-Arkeologia), Supl. No 8, San Sebastian, 95-98.

PÁLFI, GY. (1989): Etude paléopathologique des tumeurs osseuses malignes du VIIIe siècle. - Paléobios 5, 1, 69-76.

PÁLFI, GY. (1989): The occurrence of bone tumors in anthropological remains belonging to the Székkutas-Kàpolnadülő cemetery (Hungary) of the late Avar Period. - Acta Biol. Szeged. 35, 207-220.

PÁLFI, GY. (1990): Spondylarthropathies in Avar Age human remains. - Acta Biol. Szeged. 36, 81-94.

PÁLFI, GY. (1991): The first osteoarchaeological evidence of leprosy in Hungary. - International Journal of Osteoarchaeology1, 99 -102.

PÁLFI, GY. (1991): The osteoarchaeological evidence of vertebral tuberculosis in the 8th century. - Acta Biol. Szeged. 37, 101-105.

PÁLFI, GY. (1992): Maladies, environnement et activités: Traces sur l'os humain ancien. - Préhistoire et Anthropologie Méditerranéennes 1, 61-72.

PÁLFI, GY. et CSERNUS, Z. (1990): Arthrite infectieuse ankylosante dans une série du VIIIe siècle en Hongrie. - Paléobios 6, no 2-3, 37-41.

PÁLFI, GY., DUTOUR, O. et BÉRATO, J. (1991): Tréponématose vénérienne et migration humaine. - Résumés du XXème Colloque des Anthropologistes de Langue Française; Rome, CESI.

PÁLFI, GY., DUTOUR, O. et BÉRATO, J. (1992): A case of spondylodiscitis from the Xth century (La Roquebrusanne, Var). - MUNIBE (Antropologia - Arkeologia), Supl. No 8 (1992), 107-110.

PÁLFI,GY., DUTOUR O., BORRÉANI, M., BÉRATO, J. et BRUN, J.-P. (1992): Congenital syphilis from the Late Antiquity in France: "Birthday Present" for Columbus's Anniversary. - Journal of Paleopathology, 4, 2, 109.

PÁLFI, GY., DUTOUR, O., BORRÉANI, M., BRUN, J.-P. et BÉRATO, J. (1992): Pre-Columbian congenital syphilis from the Late Antiquity in France. - International Journal of Osteoarchaeology 2, 245-261.

PÁLFI, GY., DUTOUR, O., BÉRATO, J. et PASQUALINI M. (1992): Diseases in the Late Antiquity: - Paleopathological investigation of two anthropological series from France. - Acta Biol. Szeged. 38, 67-79.

PÁLFI, GY., FARKAS, GY. et OLÁH, S. (1992): Joint diseases in the anthropological remains coming from the period of the Hungarian Conquest. - MUNIBE (Antropologia-Arkeologia), Supl. No 8, San Sebastian, 111-114.

PÁLFI, Gy. et LECACHEUR, P. (1992): Observations ostéoarchéologiques sur les squelettes d'une sépulture gallo-romaine (Gréoux, France). - Acta Biol. Szeged. 38, 89-93.

PÁLFI, Gy. et LECACHEUR, P. (1993): Fouille d'une tombe en coffrage gallo-romaine et observations ostéoarchéologiques. - Ann. SSNATV 45, 49-53.

PÁLFI, GY., MARCSIK, A. et KOVÁCS, J. (1992): Lumbosacral and hip tuberculosis in a Migration Period skeleton. - Journal of Paleopathology 4, 3, 179-184.

PÁLFI, GY. et OLÁH, S. (1991): A possible case of leprosy. (In: Farkas, Gy. (ed.): Papers of the Anthropological Session in Szeged.) - Szeged-Ulm, pp. 207-215.

Sous presse:

DUTOUR, O., PANUEL, M., PÁLFI, GY. et BÉRATO, J. (sous presse): A foetal pathological case dating from the IVth century in France and its possible consequences on the history of human treponematosis. - The Lancet, London.

PÁLFI, GY. (sous presse): Traces d'activités sur les squelettes des anciens Hongrois. - Bulletins et Mémoires de la Société d'Anthropologie de Paris.

PÁLFI, GY., BÉRATO, J., ZAKARIAN, H., COMMANDRÉ, F. et DUTOUR, O. (sous presse): Un cas antique d'hyperostose vertébrale ankylosante. - Rhumatologie.

PÁLFI, GY., DUTOUR, O. et BÉRATO, J. (sous presse): Tréponématose vénérienne et migration humaine: Nouvelles données à propos d'un cas de syphilis congénitale précoce chez un foetus du IVème siècle ap. J.C. (Costebelle, Hyères, Var, France). - Rivista di Antropologia (Roma).

PÁLFI, GY., DUTOUR, O. et BÉRATO, J. (sous presse): Traumas and activities: A case report about a polytraumatism from the Late Antiquity in France. - Journal of Paleopathology.

PÁLFI, GY., DUTOUR, O. et BÉRATO, J. (sous presse): Etude paléopathologique de la série gallo-romaine de Costebelle (Hyères, Var). - Paléobios.

PÁLFI,GY., DUTOUR, O., BORRÉANI, M., BRUN, J.-P. et BÉRATO, J. (sous presse): "Birthday Present for the Columbus's Anniversary" - Congenital syphilis from the Late Antiquity in France. - Proceedings of the 9th European Meeting of the Paleopathology Association, Barcelona, 1992.

ACTA BIOL. SZEGED. 39. pp. 125-136 (1993)

PHYTOSOCIOLOGICAL METHODOLOGY AND METHODICS IN WORKS BY LAJOS TIMÁR

I. BAGI

Department of Botany, József Attila University
H-6701 Szeged P.O.B. 657, Hungary

(Received: April 30, 1993)

Abstract

A high proportion of works by L. TIMÁR's scientific oeuvre belongs to phytocenological literature. On the occasion of the 75th anniversary of his birth, a valuation of the methodology and methodics of his phytocenological works and a complete list of his publications are presented in this paper hoping that his forgotten or not sufficiently known works may get into the scope of scientific society by this commemoration.

Key words: history of vegetation science, TIMÁR LAJOS, Zürich-Montpellier Phytosociological School

Material and Methods

The citation of TIMÁR's publications issued from the peculiarities of this article does not follow the citation system of Acta Biol. Szeged.; titles of his works are cited by using the serial numbers of the "Bibliography", e.g. (See 10). The works of other authors are cited regularly and the cited works can be found in the "References".

Discussion

Disciplinary remarks

In TIMÁR's scientific concept, geobotany studied by him is an independent discipline of natural geography. Geobotany consists of the following parts: floristical geobotany (plant geography=phytogeography); its subject is the distribution of plant species in space (here geographical space), genetical geobotany (here vegetation history), cenological geobotany (description of the units of the vegetation and their classification) and ecological geobotany (effects of the environment, first of all abiotic, on the vegetation structure). In the modern sense, his geobotany does not correspond to "plant ecology", and neither is synonymous with "(plant)synbiology", because it is wider than that, as it includes chorology and the vegetation history, as well. At the same time, some parts of the methodological system of these (e.g. areal elements) have often been applied to answer questions of ecological features. The two

disciplines remained, cenological and ecological geobotany, are adequate for "synfenobiology" and "(plant)synecology"=Ökologie, respectively. These two form "synbiology" of plants together which is more or less equal with "plant ecology" (cf. JUHÁSZ-NAGY, 1986; PETERS, 1991). Geobotany, in this relation, corresponds to "vegetation science".

Science historical remarks

Although TIMÁR's first cenological article (See 1) was published in 1943, his phytosociological activity unfolded by the end of the 40s. At that time, the Zürich-Montpellier (ZM) Phytosociology School (first of all its BRAUN-BLANQUET approach) undoubtedly had the greatest influence on Hungarian geobotany. In laying the foundations of the dominance of this school, works of SOÓ (1934, 1950), ZÓLYOMI (1934) and FELFÖLDI (1942, 1943) had a decisive importance. ZÓLYOMI as the director of the Eötvös College led TIMÁR's attention towards geobotany (TIMÁR was a postgraduate student at that time). TIMÁR wrote his M.Sc. thesis (See 2,8) under the direction of academician Prof. SOÓ in 1946. These direct personal connections necessarily oriented him to accept ZM methodology and methodics.

A high degree of flexibility of the school had been shown at that time, and it was also very important in its acceptance, and it made the School almost exclusively applied: without any shocks, it was able to integrate into itself the most powerful results of the physiognomic schools (e.g. life forms, growing forms, areal elements), the consociation and typology theories of the northern traditions, the succession conceptions and the climax theories of the organismic schools as well as their gradually refinding ideas on the inter- and intraspecific competition.

The ZM School had many different but more or less coherent branches. These are all agreed in some common assumptions, e.g. the basic unit of the vegetation is the association, which can be distinguished by its floristical composition, the units may be classified by the constant and so called 'character' species, the composition is mainly determined by abiotic factors (climate, soil conditions etc.), the composition is influenced by interspecific interactions (as a consequence, due to the existence of interspecific effects, the consistent concordancy presumption of the physiognomic schools was alternated to a certain extent). ZM School regards associations as being able to be classified into higher hierarchical syntaxa that also have character species on their own levels.

Although TIMÁR cited only a few textbooks in his works (SOÓ, 1934; FELFÖLDI, 1943) - knowing the library of the late Botanical Institute - supposedly, he could get the most well-known works of physiognomic schools (DE CANDOLLE, 1855; DRUDE, 1890; GRAEBNER, 1909; GRISEBACH, 1872; HAYEK, 1916; KERNER, 1863; WARMING and GRAEBNER, 1918), the impressive publication of MEUSEL (1939) had been at him disposal and he got information on the actual state of the 'Anglo-American' as well as Soviet vegetation science in way of his personal acquaintances with the leading Hungarian scientists who have had a great ability to overview whole scientific field (SOÓ and ZÓLYOMI, 1951).

TIMÁR's phytosociological works

Methodological characteristics

TIMÁR had a settled conviction that a cenological relevé is able to characterize its habitat (or environment) in an adequate way. That is why his numerous publications that according to their title seem to be floristical ones contain cenological data (See 5, 6, 9, 16, 18, 36, 38-40). His definitions of the association that have been declared in his works, interestingly, did not follow the association concept of SOÓ (1934) (which, however, originated from BRAUN-BLANQUET (1928)): "The association is a community of plants which has a certain and constant floristic composition repeating itself in its every specimen. It has uniform physiognomy and develops under similar environmental conditions". From TIMÁR's (quasi)definitions the criteria of 'constant floristic composition' and 'self-repetition in every specimen' are missing: "The (plant)associations as plant communities having sensibility against the changes of edaphical and microclimatological conditions present the real vegetation feature of a landscape. Thus the soil and the microclima can be characterized by them" (See 14, on page 490). Or "Every characteristic of a plant association is determined by the ecological relations of its habitats" (See 11, on page 55), namely, by emphasizing the abiotic habitat conditions, TIMÁR turned back to the classical definition of FLAHAULT and SRÖTER (1910): "The association is a community of plants with certain floristic composition, with uniform habitat conditions and uniform physiognomy." TIMÁR's works refer to the emphasis on habitat conditions as well as the prominence of the concordancy approach of the physiognomic schools. It can also be illustrated very well by the following quotation: "As the vegetation primarily depends on the climate, the soil and the water conditions its research is adequate and complete only in relation to them" (See 27, on page 228).

The other fact which questions the constant and certain floristic composition of every specimen of an association is issued from the characteristics of the objects that had been investigated by TIMÁR; A considerable part of his works studies the vegetation of river flood-plains including the communities that are in early stages of vegetation succession (See 1-3, 7, 8, 14, 17, 21,28,30,31). The other significant part of his works discusses weed communities (of plough-lands) (See 5, 9, 10, 11, 13, 18, 20, 22, 23, 26, 29, 32, 34, 35). In both cases, but particularly in the second one, a considerable variability characterizes the association specimens (phytocenoses). TIMÁR had no doubt that the mechanical application of BRAUN-BLANQUET's definition conduces to the inevitable increase of the number of cenotaxa in case of weed and ruderal communities. (As later it had been ensued cf. e.g. THEURILLAT and MORAVEC (1992).) In order to avoid this danger, he introduced the basic association conception (See 20). Unfortunately, his phytocenological results in this field did not become well-known, consequently, in all probability, vegetation units with facies or subassociation values and their seasonal variants (aspects) had been described as independent associations resulting an incalculable and unsuccedingly expanding syntaxa-system.

Another result of the object chosen by TIMÁR was his high interest shown in the vegetation units that change fast. He published several schemes of succession of river banks and weed communities (See 8, 11, 20, 34), but his explanation according to which the zonation system is the result of the succession led him to declare unfounded conclusions (See 34).

As a consequence of TIMÁR's undergraduate courses, he regarded vegetation mapping as the final synthesis of geobotanical work as well as the highest degree of the documentation of the vegetation: "One of the final aim of the studies of the associations is their localization in the field, namely, elaboration of geobotanical maps" (See 27, on page 230). As a realization of his aims, he published detailed vegetation maps in many of his works (See 3, 8, 30, 31, 33, 37). The importance of his activity in this field is emphasized by the fact that the 'International Bibliography of Vegetation Maps' knows about 30 published vegetation maps from Hungary from the 1943-1959 period, moreover, between 1943 and 1953 only TIMÁR's three vegetation maps are mentioned (HORVÁTH, 1966).

Methodical characteristics

In the tabulation of cenological relevés, TIMÁR applied a simplified BRAUN-BLANQUET method. His cenological relevés contain only the dominance values (on + and 1-5 scale) in every case, he did not apply the sociability values. Vitality values are only mentioned in exceptional cases (See 22), but the system of ELLENBERG (1952), which is, however, identical with that of Braun-Blanquet has already been referred to. The synthetical parameters (A-D values, constancy) were applied regularly.

The interpretation of the cenological data were almost entirely performed by the help of the life forms of RAUNKIAER (1937) and by the ranking of the species into areal element categories (MÁTHÉ, 1951). Statistical methods were not used.

The ecological (biological) spectrum based on the life forms is informative for the physiognomical characteristics of vegetation, it reflects the position of the association in the successional series as well as the abiotic factors, mainly the climatic ones, it refers to the existence of disturbation or even the natural conditions of the vegetation (See 1-3, 5, 7, 8-11, 13-15, 17-20, 22, 32-35, 37). The interpretation of the ecological spectrum may be extended for a given territory (See 14, 17, 21, 31). TIMÁR expressed his opinion on the habitat depending changes of life forms (See 29).

The floristical spectrum based on the areal element distribution in a community or a territory refers to the aboriginality, naturality and origin of the vegetation units. Indirectly, some conclusions can be drawn from the climatic demands of the vegetation (See 1-3, 5, 7-11, 13-15, 17-22, 32-35, 37). Although in TIMÁR's time the nature protection value estimation of a community or a territory was not such a central problem as it is nowadays, his moderate interpretations are exemplary from this point of view.

Summary

LAJOS TIMÁR augmented our knowledge mainly in the following fields of vegetation science: phytosociological description of the vegetation of flood-plains and their zonational and successional relations; rules of the development of weed communities and their cenological description and syntaxonomy; geobotany of the south-eastern part of the Great Hungarian Plain and description of its flora and vegetation.

References

BRAUN-BLANQUET, J. (1928): Pflanzesociologie. Grundzüge der Vegetationskunde. - Springer, Berlin. pp. 330.

CANDOLLE, A.M. DE (1850): Geographie Botanique. - Masson, Paris, 2 Vols. pp. 1365.

DRUDE, O. (1890): Handbuch der Pflanzengeographie. - Engelhorn, Stuttgart. pp. 582.

ELLENBERG, H. (1952): Landwirtschaftliche Pflanzesoziologie. II. Wiesen und Weiden und ihre standörtliche Bewertung. - Eugen Ulmer, Stuttgart. pp. 143.

FELFÖLDY, L. (1942): Szociológiai vizsgálatok a pannóniai flóraterület gyomvegetációján (Soziologische Untersuchungen übver die pannonische Ruderalvegetation. In Hungarian with German summary). - Acta Geobot. Hung. *5*, 87-140.

FELFÖLDY, L. (1943): Növényszociológia (Phytosociology. In Hungarian). - Debrecen. pp. 135.

FLAHAULT, C. and SCHRÖTER, C. (1910): Rapport sur la nomenclature phytogéographique. - Actes 3me Congr. Internatl. Bot., Bruxelles *1*, 131-164.

GRAEBNER, P. (1909): Pflanzengeographie. - Quelle and Meyer, Leipzig. pp. 165.

GRISEBACH, A. (1872): Die Vegetation der Erde nach ihrer klimatischen Anordnung. - Englemann, Leipzig, 2 Vols. pp. 603 and 709.

HAYEK, A.E. (1916): Die Pflanzendecke Österreich-Ungarns. - Deuticke, Leipzig, Wien, pp. 601.

HORVÁTH, A.O. (1966): Hungary. In: KÜCHLER, A.W. (ed.): Vegetation maps of Europe. - University of Cansas Libraries, Lawrence, 372-396.

JUHÁSZ-NAGY, P. (1986): Egy operatív ökológia hiánya, szükséglete és feladatai (The lack, the need and tasks of an operative ecology. In Hungarian). - Akadémiai Kiadó, Budapes. pp. 251.

KERNER, A. (1863): Das Pflanzenleben der Donauländer. - Wagner, Innsbruck. pp. 348.

MÁTHÉ, I. (1951): Florisztikai növényföldrajz. (Floristical geobotany). In: SOÓ, R. and ZÓLYOMI, B. (eds.): Növényföldrajzi térképezési tanfolyam jegyzete (Compiled lectures of the course on geobotany and vegetation mapping. In Hungarian). - Vácrátót, Budapest, 38-43.

MEUSEL, H. (1939): Die Vegetationsverhältnisse der Gipsberge im Kyffhäuser und im südlichen Harzvorland. Ein Beitrag zur Steppenheidefrage. - Hercynia *2*, 1-372.

SOÓ, R. (1934): A növényföldrajz alapvonalai (Fundamentals of geobotany. In Hungarian). - Debrecen. pp. 35.

SOÓ, R. (1950): A korszerű növényfölrajz kialakulása és mai helyzete Magyarországon (Die Entwicklung und heutige Lage der modemen Geobotanik in Ungarn. In Hungarian). - Ann. Biol. Univ. Debrecen *1*, 4-26.

SOÓ, R. and ZÓLYOMI, B. (eds.) (1951): Növényföldrajzi térképezési tanfolyam jegyzete (Compiled lectures of the course on geobotany and vegetation mapping. In Hungarian). - Vácrátót, Budapest. pp. 186.

THEURILLAT, J.-P. and MORAVEC, J. (1992): Index of new names of syntaxa published in 1989. - Folia Geobot. Phytotax., Praha *27*, 69-101.

WARMING, E. and GRAEBNER, P. (1918): Warming's Lehrbuch der ökologischen Pflanzengeographie. - Borntraeger, Berlin, 3rd ed. pp.988+64.

ZÓLYOMI, B. (1934): A Hanság növényszövetkezetei (Die Pflazengesellschaften des Hanság. In Hungarian with German summary). - Vasi Szemle *1*,146-174.

Bibliography

/1/ TIMÁR, L. (1943): A tutajok növényzete a Tisza szegedi szakaszán (Die Pflanzenwelt der Flösse auf dem Szegeder Abschnitt der Tisza. In Hungarian with German summary). - Acta Bot. Univ. Szeged *2*, 43-53.

[A description of the vegetation of rafts consisting of trees tied to each other. The trees originally lived along the upper part of River Tisza before they had been felled out; 82 species: Th 35.3 %, H 37.5 %, G 3.8 %, M 5.5 %, Ch 1.6 %, HH 14.5 %, *Cicuta virosa* and a new adventive: *Galinsoga hispida*; 10 cenological relevés: *Bidentetalia mainly Bidentetum, Echinochloo-Polygonetum*.]

/2/ TIMÁR, L. (1947): Les associations végétales du lit de la Tisza de Szolnok à Szeged. - Acta Geobot. Hung. *6*,70-82.

[A preliminary report to 8; A short description of *Phragmition, Nanocyperi-on=Elatini-Eleocharition, Agrostidion=Agropyro-Rumicion, Bidention=Bidentetalia, Arction lappae, Salicion albae* incl. *Salicion triandrae* alliances; succession seria for sandy, silty and clayey river banks; geomorphological profiles of flood-plain cross sections.]

/3/ TIMÁR, L. (1946-47): Egy szolnoki zátonysziget benépesedése (La colonisation d'un ilot de sable près de Szolnok. In Hungarian with French summary). - Alföldi Tud. Int. Évk. *2*, 165-170. (1948).

[Vegetation map; 4 cenological relevés: *Dichostylidi-Gnaphalietum* (?), *Chenopodion rubri*; 62 species: Th 45.1 %, H 42.0 %, M 1.6 %, G 6.4 %, HH 4.9 %.]

/4/ TIMÁR, L. (1948): A Tisza- és Marosmente új növényei (Neue Pflanzenfunde im Gebiete des Tisza- und Marosflusses /Sic!/. In Hungarian with German summary). - Borbásia 8, 58-61.

[New species, subspecies, varietas and formas (73); new for Crisicum 20, e.g. *Eleusine indica, Potentilla norvegica, Euphorbia maculata*.]

/5/ TIMÁR, L. (1949): A háború utáni gyomosodás (Expansion des mauvaises herbes après la deuxieme /sic!/ guerre mondiale. In Hungarian with French summary). Acta Geobot. Hung. *6*, 108-113.

[10 cenological relevés from *Amarantho-Chenopodietum*, and 10 from *Polygonetum avicularis=Sclerochloo-Polygonetum* in the towns of Szeged and Szolnok.]

/6/ TIMÁR, L. (1949): Az *Asperula humifusa* M.B. Magyarország új növénye *Asperula humifusa* M.B. eine neue Pflanzenart in Ungarn. In Hungarian with German summary). - Borbásia *9*, 101-102. (1950).

[On a trampled habitat of Szeged in a high number.]

/7/ TIMÁR, L. (1950): A Marosmeder növényzete (Die Vegetation des Flußbettes des Maros. In Hungarian with Russian and German summaries). - Ann. Biol. Univ. Szeged *1*, 117-136.

[Zonation system; cenological relevés: *Cypereto-Juncetum=Cypero-Juncetum bufonii* (5), *Echinochloeto-Chenopodietum polyspermi=Echinochloo-Bidentetum* (5), *Convolvulus-Echinochloa-Polygonum* 'complex' (5), *Bidentetum tripartitea Bidens* fac. (5), *Xanthium italicum* fac. (5), *Echinochloeto-Polygonetum lapatifolii* (5), *Populeto-Salicetum triandrae=Salicetum triandrae* (5); enumeratio: 229 species and formas.]

/8/ TIMÁR, L. (1950): A Tiszameder növényzete Szolnok és Szeged között (Die Vegetation des Flußbettes der Tisza zwischen Szolnok und Szeged. In Hungarian with Russian summary). - Ann. Biol. Univ. Debrecen *1*, 72-145.

[Historical review; ecological and geomorphological characterization of territories; vegetation map; cenological relevés: *Scirpo-Phragmitetum* (22), *Dichostylieto-Gnaphalietum* (14), *Agrostidetum albae* (See 2) (28), *Bidentetum tripartitae* (20), *Echinochloeto-Polygonetum* (6), consoc. *Echinochloa* (15), *Chenopodietum rubri=glauci-rubri* (5), *Populeto-Salicetum Salix triandra* fac.=*Salicetum triandrae* (28), *Amarantho-Chenopodietum* (9), *Hordeetum murini=Bromo arvensi-Hordeetum murini* (5), *Polygonetum avicularis* (See 5) (9), *Salicetum mixtum=Salicetum albae-fragilis* (?) (10); enumeratio: 432 species.]

/9/ TIMÁR, L. (1950): Az *Euphorbia maculata L.* elterjedése és társulásviszonyai (Verbreitung und Zönologie der *Euphorbia maculata L.* In Hungarian with Russian and German summaries). - Ann. Biol. Univ. Debrecen *1*, 208-210.

[In trampled habitats; 5 cenological relevés, constant species are *Euphorbia maculata, Digitaria sanguinalis, Polygonum aviculare, Taraxacum officinale*; history of spreeding.]

/10/ TIMÁR, L. (1950): A szegedi vár növényzete (Vegetation der Burgruine von Szeged. In Hungarian with Russian and German summaries). - Ann. Biol. Univ. Debrecen *1*, 211-213.

[70 plant species incl. 6 mosses new for Szeged e.g. Polygonum kitaibelianum; 2 cenological relevés with *Sisymbrium loeseli* and *Erodium ciconum*.]

/11/ TIMÁR, L. (1951): Vegetációtanulmány kerti gyomjainkon (Vegetations-studie an unseren Gartenkräutern. In Hungarian with Russian and German summaries). - Ann. Sect. Horti- et Viticult. Univ. Sci. Agric. *2/2*, 55-71. (1953).

[Cenological relations of the garden weeds; in spring: *Consolida orientalis - Vicia striata* ass. (20), in autumn: *Hibiscus trionum - Eragrostis megastachia* ass. (20) and 16 relevés from different cenoses; successional relations.]

/12/ TIMÁR, L. (1951): Vadvirágok Szeged piacain (Wilde Blumen auf den Märkten von Szeged. In Hungasrian with Russian and German summaries). - Ann. Sect. Horti- et Viticult. Univ. Sci. Agric. *2/2*, 109-116. (1953).

[122 species: 99, incl. grasses and decoration, 23 for medicinal use, 7 for their fruits; *Ornithogalum boucheanum, Castalia=Nymphaea alba, Eryngium planum, Clematis integrifolia, Gentiana pneumonanthe* (from Pusztamérges).]

/13/ TIMÁR, L. (1951): Gyomvizsgálatok a Szeged-kömyéki kender-, len- és gyapotvetésekben (Examination of weeds in the hemp, flax and cotton crops around Szeged. In Hungarian with English and Russian summaries). - Ann. Biol. Univ. Hung. *1*, 447-454. (1952).

[Cenological relevés (10-10) from the stands of different cultivated plants. *Convolvulus arvensis* is a constant species in every stand. The improtant species are: *Chenopodium album, Setaria viridis* in hemp culture, *Adonis aestivalis, Sinapis arvensis, Cirsium arvense, Polygonum amphibium, P. convolvulus* in flax cultures and *Setaria viridis* in cotton culture.]

/14/ TIMÁR, L. (1952): A Délkelet-Alföld növényföldrajzi vázlata (Pflanzengeographische Skizze des südöstlichen Alföld. In Hungarian). - Földr. Értes. *1*, 489-511.

[A geobotanical survey of the south-eastern part of the Hungarian Lowland: flood-plains of the rivers Berettyó and Körös (909 species), loess terrain of Békés-Csanád (757 species), flood-plain of the river Maros (705 species);historical remarks; a short review of plant associations; floristical and ecological analyses of 1092 species.]

/15/ TIMÁR, L. (1952): Egyéves növénytársulások a Szeged környéki szikesek iszapján. I. (Einjährige Pflanzengesellschaften auf dem Schlamme der Alkaliböden in der Umgebung von Szeged. In Hungarian with German and Russian summaries). - Ann. Biol. Univ. Hung. *2*, 311-321. (1954).

[Cenological relevés from *Crypsidetum aculeatae* (10), *Heliotropieto (supini)-Verbenetum supini=Heliotropio-Verbenetum supinae* (40) and first description of *Lythr(et)o-Pulicarietum* association (10 relevés).]

/16/ TIMÁR, L. (1952): Adatok a Tiszántúl (Crisicum) flórájához (Angaben zur Flora des Gebietes jenseits der Theiss. In Hungarian with German and Russian summaries). - Ann. Biol. Univ. Hung. *2*, 491-499. (1954).

[Historical remarks; 483 species, varietas and formas: 1 *Charales* (*Tolypella prolifera*), 16 *Lichenes*, incl. *Physcomitrium pyriforme*, 44 *Bryophyta*, 3 *Pteridophyta*, 186 *Spermatophyta*.]

/17/ TIMÁR, L. (1953): A Tiszamente Szolnok és Szeged közti szakaszának növényföldrajza (Pflanzengeographie der Theiss-Gegend von Szolnok bis Szeged. In Hungarian). - Földr. Értes. *2*, 87-113.

[A geobotanical survey of the vegetation of the Tisza flood-plain between Szolnok and Szeged; postglacial vegetation history; review and floristical analysis of communities: river bank (353 species), flood-plain (614 species), dams (513 species), flood-plain saved from inundation (incl. halophilic vegetation) (cc. 700 species), 919 species altogether; short survey of plant communities.]

/18/ TIMÁR, L. (1954): Ackerungkräuter auf alkalischem Lössboden in der Umgebung von Szeged. With Russian summary). - Acta Bot. (Acad. Sci.) Hung. 1, 193-214.

[A description of segetal vegetation of salt-affected loess based soils: *Matricarieto (chamomillae)-Atriplicetum litoralis consoc. Hordeum, Triticum* and *Zea* (50 relevés); ecological and floristical analyses of 157 species; enumeratio.]

/19/ TIMÁR, L. (1954): A Tisza hullámterének növényzete Szolnok és Szeged között. I. Vizi növényzet (*Potametea* Br.-Bl. et Tx.) (Die Vegetation des Flutraums der Tisza zwischen Szolnok und Szeged. I. Wasservegetation (*Potametea* Br.-Bl. et Tx.). In Hungarian with Russian and German summmaries). - Bot. Közlem. *44*, 85-98.

[Cenological relevés: *Nuphareto-Castalietum albae=Nymphaeetum albo-luteae* (10), *Nymphoidetum* (10), *Nymphaeetum albo-luteae, Trapa consoc.* (10), *Myriophyll(et)o-Potametum* (10), *Lemn(et)o-Utricularietum* (10), *Ranunculetum aquatilis-polyphylli* (1); floristical analysis of 76 species; zonation system.]

/20/ TIMÁR, L. (1954): Szeged és környéke vetési gyomvegetációja (Segetal vegetation of Szeged and its surroundings). - Thesis, Budapest, pp. 4.

["Cenological characteristics of the weed vegetation in case of similar agrotechnological utilization are determined by the soil and the dependent segetal community. The kind of the cultivated plant is not decisive from this point of view."

"The basic association ... is the association of ploughland weeds, which develops on certain soil types of a territory from spring to autumn without sowing of the cultivated plant. It has optimal floristical composition,developing from the seed bank of the soil. Its total composition can be studied in experimental plots or old-field that are free from anthropogenic impacts."

Lectors of the dissertation were R. SOÓ and G. UBRIZSY.]

/21/ TIMÁR, L. (1954): A Tiszazug növényföldrajza (Pflanzengeographie des Gebietes Tiszazug. In Hungarian). - Földr. Értes. *3*, 554-567.

[Geobotanical survey of Tiszazug; review of plant communities; history of the research of the flora and vegetation; floristical and ecological analysis of 424 species of four main habitats: flood-plains (220), halophilic vegetation (237), loess based soils (144) and sand dunes (168).]

/22/ TIMÁR, L. (1955): Pflanzenschädlinge zwischen den Eisenbahnschienen am Theissufer. - Acta Biol. Szeged *1*, 95-112.

[Plants on the railways; vitality values; cenological relevés from the weed associations: *Amarantho-Chenopodietum* (15), *Carduo-Onopordietum acanthii=Onopordetum acanthii* (5), *Meliloto-Echietum vulgaris= Echio-Molinietum* (5), *Tribulo-Tragetum racemosi* ((5); floristical and ecological analysis of 286 species; enumeratio.]

/23/ TIMÁR, L. (1955): Egy veszedelmes gyomkártevő előőrsei Szegeden (Pioneers of a dangerous noxious plant in Szeged. In Hungarian). - Délmagyarország. Jan. 18. p. 4.

[Distribution and expansion of *Ambrosia artemisiaefolia=elatior*.]

/24/ TIMÁR, L. (1955): Egy elfelejtett szegedi természetkutató: LÁNYI BÉLA (BÉLA LÁNYI, a forgotten naturalist of Szeged. In Hungarian). - Délmagyarország, Febr. 17. p. 4.

[Curriculum vitae and scientific activity of B. LÁNYI.]

/25/ TIMÁR, L. (1956): Megemlékezés LÁNYI BÉLÁRÓL (1879-1918) (In memoriam BÉLA LÁNYI (1879-1918). In Hungarian). - Bot. Közlem. 46, 177-178.

[See 24; publication list.]

/26/ TIMÁR, L. (1956): Kontinentaler und mediterraner Klimacharakter in den Getreidesaaten in der umgebung von Szeged. - Acta Geogr. Szeged *2*, 31-35.

[Analysis of the proportion of continental and mediterranean weed species in floras of Crisicum, Praematricum, Szeged and Hungary depending on soil types and the seasonal dynamics of the vegetation.]

/27/ TIMÁR, L. (1956): A növényföldrajzi kutatások módszerei a természeti földrajz szempontjából (Geographical aspects of the geobotanical methodology. In Hungarian). - Földr. Értes. *5*, 227-232.

[Main concepts of geobotany: e.g. landscape units, vegetation history, plant association, floristical-phytocenological indication, vegetation mapping and their possible role in geography.]

/28/ TIMÁR, L. (1956): A Tisza ősi emlékei (Ancient heritage of river Tisza. In Hungarian). - Délmagyarország, Febr. 10. p.3.

[Sasér, Tőserdő.]

/29/ TIMÁR, L. (1956): Kevesebb gyom - nagyobb termés (Less weed - more harvest. In Hungarian). - Délmagyarország, Apr. 25. p. 3.

[Harmful weeds in surroundings of Szeged: 267 species on hard soils: 29 in corn, 163 in luceme, 137 in autumn hoed plant cultures and 91 on stubble fields, 213 species on sandy soils: in order as above 121, 85, 80 and 80.]

/30/ TIMÁR, L. (1956): A Tiszazug geobotanikai térképe (Geobotanische Karte des "Tiszazug". In Hungarian). - Abstracts of the 1st Congress of the Hungarian Biological Society, Budapest, p. 64.

[See 37.]

/31/ TIMÁR, L. (1957): Geobotanical map of the Tiszazug. - Acta Biol. (Acad. Sci.) Hung., Suppl. 1. p.4.

[See 37.]

/32/ TIMÁR, L. (1957): Zönologische Untersuchungen in den Äckern Ungams. - Acta Bot. (Acad. Sci.) Hung. 3, 79-109.

[Floristical and ecological analysis of weeds, See 29; soil analyses; cenotaxonomy of weed associations: *Trifolio-Medicaginion, Lolio (remoti)-Linion usitatissimi, Consolido-Eragrosti(di)on pooidis= minoris, Tribulo-Eragrosti(di)on pooidis=minoris;* literature: 56 titles.]

/33/ TIMÁR, L. (1957): Die botanische Erforschung des Sees Fehértó bei Szeged. - Acta Bot. (Acad. Sci.) Hung. *3*, 375-389.

[Geological history; vegetation history; enumeratio: 4 *Fungi*, 25 *Bryophyta*, 1 *Pteridophyta*, 111 *Spermatophyta*;floristical and ecological analysis; cenosyste-matical overview: *Potamion=Potamogetonion, Hydrocharition, Ruppion maritimae, Bolboschoenion: Bolboschoenetum amritimi* (20 relevés), *Nanocyperion, Verbenion supinae, Thero-Salicornion, Puccinellion, Beckmannion, Festucion pseudovinae, Bidention, Polygonion avicularis, Onopordion, Consolido-Eragrostion, Matricario-Chenopodion*; zonation system; vegetation map: 35 units.]

/34/ TIMÁR, L. (1957): Zonációtanulmányok szikes vizek partján (Zonationstudien an den Ufern von sodahaltigen Gewässern. In Hungarian with German summary). - Bot. Közlem. *47*, 157-163.

[Studies on the zonation systems of a shell-hole and a navvy-pit; 12 cenological relevés with various, mostly ruderal vegetation.]

/35/ TIMÁR, L. und UBRIZSY, G. (1957):Die Ackerungskräuter Ungarns mit besonderer Rücksicht auf die chemische Unkrautbekämpfung. (With Russian and English summaries). - Acta Agron. (Acad. Sci.) Hung. 7, 123-155.

[Floristical and ecological analyses of weeds; herbicide resistance studied against 2,4D-Type and MCPA-Type herbicides; list of 732 species according to their habitat type (7) and their degrees (4) of herbicide-resistance; literature: 62 titles.]

/36/ TIMÁR, L. and BODROGKÖZY, Gy. (1957): A *Lythrum linifolium* KAREL. et KIRIL. Magyarországon (*Lythrum linifolium* KAREL. et KIRIL. in Ungarn. In Hungarian with German summary). - Bot. Közlem. *47*, 119-121.

[Between Tiszasas and Tiszakürt among *Lythrum hyssopifolium*; drawings by V. CSAPODY.]

/37/ TIMÁR, L. und BODROGKÖZY, Gy. (1957): Die Pflanzengeographische Karte von Tiszazug. - Acta Bot. (Acad. Sci.) Hung. *5*, 203-232.

[Geological and pedological characterization of the territory; cenotaxonomical system of the plant associations: *Hydrocharetalia=Hydrocharietalia, Potametalia, Isoetetalia=Nanocyperetalia, Molinietalia, Puccinellietalia incl. Crypsidetalia and Artemisio-Festucetalia, Festucetalia sulcatae=valesiacae, Secalino-Violetalia=Eragrostetalia* and *Secalietalia, Bidentetalia, Onopord(i)etalia, Plantaginetalia, Salicetalia*; soil-plant relationships; vegetation map: 40 units.]

/38/ TIMÁR, L. (1960): Gombák a Tiszántúlról (Pilze aus dem Gebiete jenseits der Theiss. I. In Hungarian with Russian and German summaries). - Bot. Közlem. *48*, 235-238.

[4 *Phycomycetes=Peronosporales*, 16 *Ascomycetes*, 64 *Basidiomycetes* =*Basidiomycota*: 42 *Holobasidiomycetes* and 22 *Phragmobasidiomycetes*.]

/39/ BOROS, Á. and TIMÁR, L. (1962): A Tisza-Körös-Maros közének mohái I. (Die Moose des Gebietes zwischen dem Körös-Maros und der Theiss I. In Hungarian with German summary). - Fragmenta Bot. *2*, 33-52.

[History and critical review of the earlier bryological researches of the territory; classification of the species according to their habitats; 15 cenological relevés of *Grimmia pulvinata - Tortula muralis* ass.; phytosociological remarks; enumeration: 20 livermoss species.]

/40/ BOROS, Á. and TIMÁR, L. (1963): A Tisza-Körös-Maros közének mohái II. (Die Moose des Gebietes zwischen dem Körös-Maros und der Theiss II. In Hungarian with German title). - Fragmenta Bot. *3*, 77-96.

[The enumeration continues: 99 *Bryophyta* species; See 39.]

Documented lectures

/41/ TIMÁR, L. (1943): A tutajok növényzete a Tisza szegedi szakaszán (Die Pflanzenwelt der Flösse auf dem Szegeder Abschnitt der Tisza). - Botanikai Szakosztály 470. ülés. Dec. 9. (Ref. Bot. Közlem. *41.* (1944), p. 78.) [See 1.]

/42/ TIMÁR, L. (1947): A Tiszameder növényzete Szolnok és Szeged között (Die Vegetation des Flußbettes der Tisza zwischen Szolnok und Szeged). - Botanikai Szakosztály 493. ülés. Jan. 9. (Ref. Bot. Közlem. *44.* (1947), p. 79.) [See 2 and 8.]

/43/ TIMÁR, L. (1949): Az *Asperula humifusa* M.B. Magyarország új növénye *Asperula humifusa* M.B. eine neue Pflanzenart in Ungarn). - Magyar Növénytani Társaság 75. ülés, Oct. 4. (Ref. Borbásia *9.* (1949), p.140.) [See 6.]

/44/ TIMÁR, L. (1953): A magyar biológiai ötéves terv (The Hungarian biological Five Year Plan). - A Magyar Biológiai Egyesület Szegedi Csoportja és a Csongrád Megyei Tanács Oktatási Osztálye által rendezett Pedagógiai ankét, Febr. 5. (Ref. Biol. Közlem. *4.* (1956), p.75.)

[Report on the biological program of the Hungarian Academy of Sciences based on SOÓ's (not ZÓLYOMI's!) publication: MTA Biol. Oszt. Tud. Közlem. 2, 317-359.]

/45/ TIMÁR, L. (1953): A Tisza hullámterének növényföldrajza (Geobotanical survey of the Tisza flood-plain). - Magyar Biológiai Egyesület Szegedi Csoportja 9. ülés, Apr. 13. (Ref. Biol. Közlem. *4.* (1956), p. 76.) [See 17.]

/46/ TIMÁR, L. (1953): Beszámoló az egyesület 1952-53 évi munkájáról és további feladatairól (Report on the works of the (Hungarian Biological) Society in 1952-53 and the further programs). - Magyar Biológiai Egyesület Szegedi Csoportja 12. ülés, June 23. (Ref Biol. Közlem. *4* (1956), p.76.)

/47/ TIMÁR, L. (1953): Két behurcolt növény (*Iva xanthifolia* NUTT., *Eleusine indica* GAERTEN) elterjedési prognózisa (Expansion prognoses of two adventive plants (*Iva xanthifolia* NUTT. and *Eleusine indica* GAERTEN)). - Magyar Biológiai Egyesület Szegedi Csoportja 13. ülés, Sept. 29. (Ref. Biol. Közlem. *4.* (1956), p. 77.)

[*Eleusine indica*: Budapest, Szeged, *Iva xanthifolia*: Lakitelek.]

/48/ TIMÁR, L. (1953.): A Szeged környéki szikes lösz vetési gyomjai (Ackerungkräuter auf alkalischem Lössboden in der Umgebung von Szeged). - Magyar Biológiai Egyesület Szegedi Csoportja 15. ülés, Nov. 17. (Ref. Biol. Közlem. *4.* (1956), p. 77.) [See 18.]

/49/ TIMÁR, L. (1954): A Tiszazug növényföldrajzi térképezés I. (Geobotanical mapping of Tiszazug I.) - Magyar Biológiai Egyesület Szegedi Csoportja 24. ülés, Oct. 26. (Ref. Biol. Közlem. *4.* (1956), p. 79.) [See 21., 30., 31.,37.]

/50/ TIMÁR, L. (1955): Növényi kártevők a vasúti sinek között (Pflanzenschädlinge zwischen den Eisenbahnschienen). - Magyar Biológiai Egyesület Szegedi Csoportja 28. ülés, Febr. 22. (Ref. Biol. Közlem. *4.* (1956), p. 81.) [See 22.]

/51/ TIMÁR, L. (1955): Növényzonációk törvényszerűségei szegedi példák alapján (Remarks on the rules of the zonation of plants by examples from Szeged). - Magyar Biológiai Társaság Szegedi Osztálya (sic!) 33. ülés, Oct. 31. (Ref. Biol. Közlem. *6.* (1958), p. 79.) [See 34. (?)]

/52/ TIMÁR, L. (1956): Gyomtanulmány Szeged belvárosából (*Amarantho-Chenopodietum albi* SOÓ) (Weed studies from the centre of Szeged (*Amarantho-Chenopodietum albi* SOÓ)). - Magyar Biológiai Társaság Szegedi Osztálya 38. ülés, March 27. (Ref. Biol. Közlem. *6.* (1958), p. 81.)

[A cenological description of five facies of *Amarantho-Chenopodietum: Chenopodium album, Amaranthus retroflexus, A. deflexus, A. crispus, Polygonetum avicularis complex.*]

Related publications

/53/ GALLÉ, L. (1960): Zuzmók TIMÁR LAJOS hagyatékából (Flechten aus dem botanischen Nachlass von L. TIMÁR. In Hungarian with German summary). - Bot. Közlem. *48*, 239-244.

[48 species, several varieties and formas, incl. some rare *Physcia species*.]

/54/ SOÓ, R. (1962): TIMÁR LAJOS emlékezete (1918-1956) (Erinnerung an L. TIMÁR. In Hungarian with German summary). - Bot. Közlem. *49*, 175-179.

[Curriculum vitae and scientific activity; bibliography: 39 titles.]

/55/ KOVÁCS, Gy. (1966): TIMÁR LAJOS (L. TIMÁR. In Hungarian). - Jászkunság 12, 139-140.

[Commemoration.]

An unpublished (?) manuscript

/56/ TIMÁR, L. (cc. 1955): Népies növénynevek a Tiszamentéről (Populistic names of plants from the Tisza valley. In Hungarian). - Manuscript, Dept. of Bot., pp. 24.

[541 Hungarian names.]

ACTA BIOL. SZEGED. 39. pp. 137-139(1993)

IN MEMORIAM

LAJOS TIMÁR (1918-1956)

"If a broken twig falls down from an old tree in the forest whoever notices it...?", says LAJOS BÍRÓ, the outstanding natural scientist. The old tree grows its descendants, the new shoots...

From the Szeged family tree of researchers of flora and fauna quite a few twigs have come down before their time. Here we are referring to IMRE VELLAY, the excellent entomologist, BÉLA LÁNYI from the botanists, and the most painful loss: LAJOS TIMÁR. They all were teachers as well as hard working cultivators of their work. They were carried away by death from us before the culmination of their promising career.

I first met LAJOS TIMÁR in 1946 in the institution of REZSŐ SOÓ in Debrecen. He came to the University of Debrecen to finish the last bits of his Ph.D. thesis, and recommended to him to spend the night in my room on the uppermost floor of the institution, which served as a temporary accommodation. For the first time our talk lasted trough half of the night, and my friend, LAJOS outlined his life. The main string of his story was that finishing with his miserable youth, he wanted to be able to look after himself aiming at a "safe, financially comfortable" life - for his family, as well, - attained with his work. - But which enthusiastic young man, just starting his career, does not have same desire?

LAJOS TIMÁR lived the first half of his short life in Szolnok, and the second half mostly in Szeged. This town appreciated him during his life by helping with his work, and also in his death by granting him an honorary grave in the Szeged Central Cemetary.

LAJOS TIMÁR was born on the 25th January 1918 in Zagreb. He was the twelfth son of a MÁV (Hungarian State Railways) worker. His family escaped to Szolnok after the First World War. Here LAJOS spent his childhood and youth in Iskola street. He went to school in this town and was a pupil of the Verseghy Ferenc Secondary Grammar School. When he was a little schoolboy he was very interested in plants and insects, he made nice collections of them walking long miles up and down on the bank of the river Tisza. The narrow means of the family could not afford to pay for the further studies of the talented boy but his elder brothers took up this task. According to the commemoration of KÁZMÉR SZÁSZ, the headmaster of the school, the little boy was only interested in botany, zoology and hygienics, under the guidance of his beloved teacher, BÉLA BALOGH. He was very sorry that LAJOS could not be present at the meeting 25 years after the GCE exams. After leaving secondary school, he worked in the Town Library of Szolnok for two years as an intellectual relief worker.

In 1938 he was at the University of Debrecen, from where he went to Szeged as a teacher trainee of natural history and geography following his professor, ISTVÁN FERENCZI. He got his degree in 1943. Then for two years, he served as a soldier at the

Szolnok sappers. During the war he went to Bararia with his team, and he came back and was discharged as an honorary sergeant.

In 1945 LAJOS taught natural history at the Baross Gábor (late Móra Ferenc, and now Vedres István) General Secondary Grammar School, where he had been a teacher trainee under the direction of KÁLMÁN CZÓGLER. At that time he got into touch with BÁLINT ZÓLYOMI, a former disciple of REZSŐ SOÓ, who turned the attention of the young teacher towards plant ecology (plant sociology at that time).

When I stayed in Debrecen between 1946 and 1948 LAJOS and I still kept in touch with each other. I was interested in his life, as he worked in my old "alma mater" with my former teacher, CZÓGLER.

LAJOS TIMÁR soon left this grammar school, and for a short time, he was in charge of a course for pharmacy students in the Institute of Botany (headed by PÁL GREGUSS) of the Szeged University. In 1950 he made the soil-geological map of Szeged and its surroundings on behalf of the Hungarian Geological Institution. Previously, he took his doctor's degree in the Institute of Botany, Debrecen. The title of his dissertation was the following: Plant associations of the Tisza flood-plain between Szolnok and Szeged.

In the autumn of 1952 he worked in the Institute of Climatology at the Szeged University as a research worker with professor RICHÁRD WAGNER. In 1954 he qualified for a candidate's degree in biological studies. Most of his papers in connection with this were only published after his death.

In 1948 he married ERZSÉBET MAKLÁR, a linguist in the Italian Institute and a secondary school teacher. A son and a daughter were born from their happy marriage. Then he worked more and more - for his family, as well - this over-exertion was very harmful for his health. I read it in professor SOÓ's necrology that he had troubles with his spleen that remained from his military service. He was operated on in 1955, and short after this he died of a bad cirrhosis of the liver.

He was buried in Szeged on 18th September 1956. At his funeral, ÁDÁM BOROS delivered a speech in the name of botanists, and so did ISTVÁN SZALAI, who was a colleague of his, as LAJOS TIMÁR was the secretary of the Szeged Group of the Hungarian Biological Society.

I saw him for the last time when I visited SÁNDOR BÁLINT in the same room of the hospital lying not far from LAJOS TIMÁR. It was a special tragedy for LAJOS that he could not live to see the First Tisza-Research Expedition, which left Szeged in a month's time after his death. Thus he could not work on the monograph of his beloved river Tisza, which could have been the main opus of his life...

I will never forget our whole-day "surveys of the field" in the beginning of 1950s. We would leave Szeged on our bicycles, as usually there were no other vehicles for researchers at that time. We arrived at Levelény via Pusztaszer, where the Tisza still had one of its backwaters remained. Now there are agricultural lands there. I remember looking at the rich reed-grass in the water (it would have fitted into a novel by JÓKAI very well) from a little bridge over the river. At that time we could see some stands of *Menyanthes trifoliata, Stratiotes aloides* and *Nymphaea alba* in their

reality, and other plants delighting the eyes of the botanist from which several are lost now from the flora of Csongrád county.

I can still recall it, when LAJOS and I got off our bicycles not far from Tápé on a miserable and tiresome journey after bends of the endless river Tisza. LAJOS said, "I will elaborate the Tisza from Szolnok to Szeged. "You might drink it up, as well, LAJOS...", I answered him joyfully.

Our last cooperation was the organization of a large-scale exhibition about "The life of lake Fehértó" in the Szeged Museum, when I was planning the script of the exhibition, and I asked him to arrange the plant associations of the lake.

LAJOS TIMÁR was mainly a cenologist, he was not a "herbarist" in the common sense of the word. He would put his collected plants "in situ" onto the same page together with its associates thus giving an immediate basis for the cenological evaluation. He also collected other plant groups like mushrooms, lichens and mosses.

His colleagues, GYÖRGY BODROGKÖZY, LÁSZLÓ GALLÉ senior, ISTVÁN PRÉCSÉNYI, SZANISZLÓ PRISZTER, GÁBOR UBRIZSY and many others remembered him as an amiable personality, who did never talk too much. All of his words reflected love and honour towards Nature and its sciences.

Let his self-sacrificing, noble character be a model for the future generations of researchers. He would be 75 years old now...

In this paper I used the necrology by REZSŐ SOÓ (Botanikai Közlemények 49: 175-179, 1962) and the commemoration of GYULA KOVÁCS my late colleague from Szolnok (Jászkunság 19: 139-140, 1960).

GY. CSONGOR

ACTA BIOL. SZEGED. 39. pp. 141-146. (1993)

40 JAHRE SZEGEDER SEKTION DER UNGARISCHEN BIOLOGISCHEN GESELLSCHAFT

GY. L. FARKAS

Institut für Anthropologie der József-Attila-Universität, H-6701, Szeged, P.F. 660.

(Einrichtung der Manuscripts: 15. Februar 1993)

Auszug

Der Verfasser macht in der Veröffentlichung einen Rückblick auf die 40-jährige Tätigkeit der Szegeder Sektion der Ungarischen Biologischen Gesellschaft.

Schlüsselwörter: Szegeder Sektion der Ungarischen Biologischen Gesellschaft, Sitzungsbericht.

Einleitung

Rückblickend ist die Szegeder Sektion der Ungarischen Biologischen Gesellschaft einer der ältesten Vereine außerhalb Budapests, die 1992 nicht nur auf eine 40-jährige Vergangenheit, sondern die im Februar 1993 auch auf die 300. Sitzung zurückblicken konnte. Beide Ereignisse sind Anlaß für einen Rückblick auf die in der Vergangenheit geleistete Arbeit.

Organisatorische Fragen

Die Ungarische Biologische Gesellschaft wurde 1952 im Rahmen der Gesellschaft Technisch-Naturwissenschaftlicher Vereine (ung. METESZ) gegründet, wobei die Szegeder Sektion am 17. Mai 1952 entstand. Am 31. Mai 1955 trennte sich die Ungarische Biologische Gesellschaft von der METESZ und wurde auf einer Mitgliederversammlung unter die Schirmherrschaft der Ungarischen Akademie der Wissenschaften gestellt, wo sie ihre Arbeit forsetzte. Die Szegeder Sektion bestand jedoch in ihrer ursprünglichen Form weiter (MEGYERI, 1956).

Ab 1978 erfolgte dann wieder die Eingliederung in die METESZ und die Szegeder Sektion wurde somit wieder als eine ihrer Gruppierungen geführt. Die Einschätzung der geleisteten Arbeit der ersten 98 Veranstaltungen erfolgte in Form von Rechenschaftsberichten in den Biológiai Közlemények (Biologischen

Mitteilungen, MEGYERI, 1956; BICZÓK, 1958, 1959; GALLÉ, 1962a, 1962b, 1963). Über die Sitzungen 99-151 liegen bedauerlicherweise keine Angaben vor; von den Sitzungen 152-300 existieren die Einladungen und auf Grund der Sitzungsprotokolle lassen sich die Ereignisse rekonstruieren. Somit kann zum 40-jährigen Bestehen dieser wissenschaftlichen Gesellschaft leider nur ein unvollständiges Bild gezeichnet verden.

Auf den jeweiligen wissenschaftlichen Versammlungen wurden folgende Personen mit dem Vorsitz betraut:

AMBRUS ÁBRAHÁM, Zoologe (1952-1956, 1978-1985)
PÉTER BERETZK, Ornithologe (1957-1962)
ISTVÁN SZALAI, Pflanzenphysiologe (1968-1973)
ANDRÁS GARAY, Biophysiker (1973-1976)
LÁSZLÓ SZALAI, Biophysiker (1976-1978)
OTTÓ FEHÉR, Tierphysiologe (1985-1990)
GYULA FARKAS, Anthropologe (seit 1990)
Sekretäre der Sektion waren:
LAJOS TIMÁR (1952-1956)
PÁL SIMONCSICS (1968-1978)
LÁSZLÓ GALLÉ jun. (1978-1985)
GABRIELLA LÁZÁR (1978-1980)
JÁNOS GAUSS (1985-1990)
KÁROLY BÁBA (seit 1990)

Auf der Gründungssitsung unserer Sektion wurde folgende Zielstellungen formuliert:

1. Die Ergebnisse selbständiger wissenschaftlicher Untersuchungen werden sowohl in Publikationen als auch in Vorträgen und Besprechungen vorgestellt, um so die wissenschaftlichen Leistungen bewerten und beurteilen zu können.
2. Öffentliche Verbreitung und Berichterstattung über praxisrelevante biologische Ergebnisse.
3. Vorstellung wichtiger biologischer Arbeiten aus dem Ausland hinsichtlich ihrer Relevanz für die eigene Forschungsarbeit und die einheimische Praxis.
4. Uneigennützige Unterstützung der ungarischen Volkswirtschaft.
5. Ausbildung von jungen Forschern und Fachleuten sowie von Lehrern und ihre zunehmende Einbeziehung in den Ausbildungsprozeß.

Diese Zielstellungen beweisen eindeutig wie die neu entstandene Biologische Gesellschaft ihren Wirkungsbereich in der ungarischen Wissenschaft verstanden wissen wollte.

Herausragende Ereignisse

Die Biologische Gesellschaft veranstaltete mehrmals größere Zusammenkünfte. Darunten waren:

am 5. Februar 1953 eine für Pädagogen;
14. Februar 1953 eine für Pflanzenschutz;

29. November 1960 eine für Biologie und Schulreform;

29-30. Juni 1970 Biologie im Gymnasialunterricht und an der Universität (gemeinsam mit der Sektion Didaktik in der Ung. Biol. Gesellschaft);

26-27. Juni 1978 Fachlehrausbildung Biologie und deren Probleme (wie 1970 zusammen mit der Sektion Didaktik);

3. November 1983 Umweltschutz und Forschung in Südost-Ungarn (zusammen mit der Szegeder Sektion der Ungarischen Akademie der Wissenschaften, Arbeitsgruppe Ökologie und Naturschutz).

In 2-jährigen Intervallen veranstaltete die Biologische Gesellaschaft Ungarns ihre Haupttagungen. Davon waren die 2. (1958) (ÁBRAHÁM, 1959), die 10. (1972) und die 12. (1968) in Szeged.

Die Szegeder Biologen erinnern sich besonders gerne an herausragenden Ereignisse ihrer Mitglieder. So z.B. an die Sitzungen aus Anlaß des 75. Geburtstages von Prof. AMBRUS ÁBRAHÁM und die des Ornithologen PÉTER BERETZK (1968), an die von Prof. ÁBRAHÁM zum 80. (1973), zum 85. (1978), zum 90. (1983) Geburtstag, an die von PÁL GREGUSS (Botaniker) zum 85. (1975) und 90. (1980) Geburtstag.

Aus Anlaß ihrer Emeritierung fanden gesonderte Sitzungen statt. So z.B. für den Anthropologen PÁL LIPTÁK (1980), den Zoologen LÁSZLÓ MÓCZÁR (1982). Auf diesen Sitzungen trugen die Schüler und Kollegen ihre Arbeiten vor.

Ausländische Gäste verschiedener Sitzungen waren u.a.: V.A. SCHIRSCHOV (Sowjetunion, 1957), BÉLA GYÖRFFY (Jugoslawien, 1968), G. Knüssmann (Westdeutschland, 1963), H. SAGROMSKY (Ostdeutschland, 1968), H. METZNER (Westdeutschland, 1970), N.P. VOKRESENSKAJA (Sowjetunion, 1970), C. STRANZNICKY (1989).

Ich möchte auch daran erinnern, daß bei einigen Gelegenheiten nicht nur Szegeder Biologen ihre wichtigsten Arbeiten vorstellten, sondern daß auch ausländische Wissenschaftler ihre Erfahrungen einbrachten. So gaben z.B. Prof. JÁNOS BALOGH (1968, 1986), Prof. TAMÁS PÓCS (1976), Prof. BÉLA JANKÓ (1977), Prof. PÉTER TÉTÉNYI (1977, 1978) und Prof. PÁL JUHÁSZ-NAGY (1978) ihre Arbeit den Kollegen preis.

Auf Grund ihrer herausragenden Arbeiten verlieh die Ungarische Biologische Gesellschaft 1962 dem Szegeder Neurohistologen Prof. AMBRUS ÁBRAHÁM und dem Anthropologen Prof. LAJOS BARTUCZ die Ehrenmitgliedschaft (BIZCÓK 1967; EIBEN 1967). Am 26. November 1985 wählte die Ungarische Biologische Gesellschaft AMBRUS ÁBRAHÁM zu ihrem Ehrenvorsitzenden.

Themen der Sitzungen und Zahl der Vortragenden

Der Themekreis und die Zahl der Vorträge sind in Tabelle 1 zusammengefaßt. Es war allerdings nicht immer ganz einfach, die Vorträge einem einzelnen Wissensgebiet zuzuordenen.

Auf den ersten nahezu 100 Veranstaltungen wurden von 371 Autoren 309 Vorträge dargeboten; auf den Sitzungen 152-300 waren 523 Autoren mit 428

Vorträgen präsent. Bei den nahezu 300 Versammlungen waren 247 in Folge. Über 53 Sitzungen fehlen genaue Angaben. Wenn man die abgehaltenen Veranstalltungen mit je 5-6 Vorträgen vorsichtig hochrechnet, dürfte die Zahl tatsächlich gehaltener Vorträge bei ca. 800 liegen und ca. 1070 Autoren daran beteiligt gewesen sein.

Der Rahmen der Vortragstehmen war äußerst vielseitig und umfaßte die gesamte Biologie. Natürlich beeinflußte der jeweilige Vorsitzende der Sektion die Thematik der Veranstaltungen, denn das Fachinteresse wurde weitestgehend von ihm vertreten. Leider zeigte sich dabei auch, daß z.B. solche Themen wie die Hydrobiologie, Protozoologie oder Bodenkunde mit dem Tod der jeweiligen Szegeder Vertreter aufhörten, zu bestehen.

In der Thematik der Veranstaltungen zeichnete sich auch die Weiterentwicklung der Biologie ab. In den letzten Jahren dominierten verstärkt die Genetik, die Ökologie, physiologische Themen und die Biotechnologie. In den letzten Jahren nahmen längere Auslandsreisen zu und somit erhöhte sich auch die Zahl der Berichterstattungen. Nur in geringer Zahl vertreten waren in den letzten Jahren Vorträge aus den Bereichen Mikrobiologie, Hydrobiologie und Paläontologie. Glücklicherweise konnten jedoch die Traditionen der hochbetagten lebenden oder schon verstorbenen Szegeder Wissenschaftler durch die Arbeit der Szegeder Sektion der Ungarischen Biologischen Gesellschaft bis heute erhalten werden. Tabelle 1 macht deutlich, daß Bereiche der Neurobiologie und der Botanik mit 83 Vorträgen dominierten. Angestiegen war auch die Zahl der Veranstaltungen mit Themen aus der Wissenschaftgeschichte, der Physiologie und Genetik.

Besucher der Sitzungen

Über die Teilnehmerschaft an den Sitzungen gibt es im Gegensatz zur Thematik der Veranstaltungen nur sehr ungenaue Informationen. Genaue Zahlen liegen nur für den Zeitraum der 59.-98. sowie der 152.-300. Sitzungen vor. Danach waren auf 239 Veranstaltungen 7202 Teilnhmer; das bedeutet im Durchschnitt waren 30 Teilnehmer anwesend. Die größte Teilnehmerzahl gab es am 17. November 1959, wo aus Anlaß der Bereichterstattung von Prof. PÁL GREGUSS über seine Kanadareise 500 Personen anwesend waren.

Künftige Aufgaben

Die Durchschnitt und Einschätzung der vergangenen Ereignisse muß die Bewertung der künftigen Aufgaben bestimmen. Was lehren und dabei die gemachten Erfahrungen?

In erster Linie, daß diese seit 40 Jahren bestehende Sektion nicht aufhören darf, zu existieren. Die Themenwahl der Veranstaltungen ist dabei von entscheideneder Bedeutung. Die Zuhörerschaft wird von den Erinnerungen an bekannte Forscher

angezogen. Derarting gestaltete Vorträge werden nicht von der Achtung vor der Leistung dieser Fachleute getragen, sondern dienen auch der Traditionspflege.

Die Geschichte der Wissenschaft, das Bekanntmachen der eigenen Arbeiten ist von Zeit zu Zeit wichtig, und zwar nicht nur in gedruckten Form. Notwendig erscheint mir, daß zwischen den Hauptveranstaltungen gesonderte "Tage der Biologie" geplant werden, an denen die biologische orientierten Bereiche unserer Universität und des Szegeder Akademie-Forschungsinstituts für Biologie ihre Arbeiten vorstellen können.

Tabelle 1: Nach Fachgebieten aufgeschlüsselte Verteilung der Vorträge.

Thematik	Zahl der Vorträge	
	1.-98	152.-300.
	Sitzungen	
Organisatorische Fragen	3	8
Rückblicke	7	17
Wissenschaftsgeschichte u.a.	9	21
Reiseberichte	16	26
Buchbesprechungen	3	18
Methodik	6	9
Allgemeine Biologie	13	8
Ökologie	7	36
Neurohistologie, Histologie	37	46
Zoologie (Einzeller)	19	3
Mikrobiologie	17	5
Zoologie (Mehrzeller)	15	25
Tier- u. Humanphysiologie	11	28
Ornithologie	11	16
Botanik	41	17
Pflanzenphysiologie	39	44
Pflanzezucht, -schutz	7	25
Hydrobiologie, Limnologie	14	4
Anthropologie	6	19
Paläontologie	18	7
Genetik	1	36
Biotechnologie	-	3
Bodenkunde	5	1
Geographie, Astronomie	3	1
Unterricht/Didaktik	1	5
Zusammen:	**309**	**428**

Schließlich, aber durchaus nicht an letzten Stelle, sollte die Zahl der Zuhörerschaft vergrößert werden. Besonders wichtig erscheint dabei die Frage, wie die jungen Biologengenerationen in die Gestaltung dieser Arbeit einbezogen werden kann. Auf der Grundlage der dargebotenen Fakten besteht die berechtige Annahme, daß die Szegeder Sektion der Ungarischen Biologischen Gesellschaft auch künftig ihre Anziehugskraft beibehalten wird.

Literatur

ÁBRAHÁM, A. (1959): Die 2. Hauptversammlung der Ungarischen Biologischen Gesellschaft (ung.). - Biol. Közl. *7*, 127-129.

BICZÓK, F. (1958): Rechenschaftsbereich über die Arbeit der Szegeder Sektion der Ungarischen Biologischen Gesellschaft von Oktober 1955 bis Januar 1957 (ung.). - Biol. Közl. *6*, 79-82.

BICZÓK, F. (1959): Rechenschaftsbereich über die Arbeit der Szegeder Sektion der Ungarischen Biologischen Gesellschaft von März 1957 bis Oktober 1958 (ung.). - Biol. Közl. *7*, 136-144.

BICZÓK, F. (1967): Nachrichten der Ungarischen Biologischen Gesellschaft. AMBRUS ÁBRAHÁM (ung.). - Biol. Közl. *15*, 33-34.

EIBEN, O. (1967): Nachrichten der Ungarischen Biologischen Gesellschaft. LAJOS BARTUCZ (ung.). - Biol. Közl. *15*, 34-35.

ACTA BIOL. SZEGED. 39. pp. 147-148 (1993)

OVERVIEW OF OUR TEMPUS-JEP PROGRAM

The start of TEMPUS-JEP (Trans-European Mobility Scheme for University Studies- Joint European Proposals) program of biology departments at Attila József University was marked by the letter of Prof. CHARLES SUSANNE of Vrije Universiteit Brussel to Prof. GYULA FARKAS in the spring, 1990. Thereafter, in summer of the same year Prof. SUSANNE come to Szeged to see the biology departments, and invited us to join the TEMPUS program organized by him.

The TEMPUS was specifically designed by the European Community for Central/Eastern Europe to promote the development of the higher education system in this region, starting with Poland, Hungary and Czechoslovakia and then soon after with Bulgaria, Romania, Yugoslavia, Albania and the 3 Baltic countries. As indicated by the its title (TEMPUS-BIOLOGY) with priority areas identified as such: agriculture and agro economics; and biotechnology and environmental protection, the program forms part of the overall program of Community aid for the economic restructuring of the countries of Central/Eastern Europe. TEMPUS exist alongside other programs, drawing simultaneously on parts of COMMETT, ERASMUS, LINGUA, etc., but having distinct identity of its own, with specific aims, grant conditions and priorities. All financial support under TEMPUS is available for trans-European activities only in which there is participation by organizations within the eligible countries of Central/Eastern Europe on the one hand, and organizations within Member States of the European Community on the other hand. The activities supported by TEMPUS fall into three broad categories: JEPs, Mobility Grants for Staff and Students, and for Complementary Activities. JEPS includes universities and/or other enterprises for cooperative education and training actions, e.g. curriculum development activities, continuing education and retraining schemes, development of open and distance learning provision; Structural development of higher education, e.g. creation of new or restructuring of existing higher education centers or institutions, upgrading of facilities, development of university capacities to cooperate with industry; Sector specific actions, e.g. development of education/training capacities at the higher education level in priority areas. Mobility grants support staff (higher education teachers and administrative staff, trainers from enterprises) moving from Central/Eastern Europe to the European community or vice versa for teaching and training assignments, practical placements and short visits for specific activities. In addition it supports students moving from Central/Eastern Europe to the European community and vice versa for periods of study and practical placements. Complementary activities include support for activities for instance for European associations in higher education; publications and information activities.

Our TEMPUS-JEP consists of projects with possibilities for infrastructural development of participating partners as well as exchanges of both staff and of students. One of the notable feature of the program is that all biological departments of the Attila József University are involved in its activities. Therefore it covers all aspects of biological sciences taught here, and as such provides good possibilities for cooperation in the restructuring process at all levels of higher education of biology including post-

graduate training.

On part of the European Community the following universities participate in the program: Univ. Complutense de Madrid, Vrije Univ. Brussel, Univ. degli studi di Firenze, Kings College London, Univ. College North Wales, Univ. libre de Bruxelles, Univ. Barcelona, Univ. Montpellier II, Univ. Autonoma de Madrid, Univ. Aix Marseille III, Univ. de Lisboa, Univ. del Pais Vasco, Univ. of Crete, II Univ. degli studi di Roma, Univ. of Manchester, Aristotle Univ. of Thessaloniki, Aarhus Universitet, Rijks-universiteit Leiden, Univ. Instelling Antwerpen, Univ. degli studi di Torino, Georg August Univ. Göttingen, Rijksuniversiteit Groningen, Johannes Gutenberg Univ. Mainz, Univ. Dublin Trinity College, Univ. Toulouse Paul Sabatier, Univ. Bordeaux I, Democrites Univ. of Thrace.

The eligible countries involved: József Attila Univ. of Szeged, Univ. of Warsaw, Jagellonski Univ. of Krakow, Wroclawskiego Univ. of Wroclaw, Komenskeho Univ. of Bratislava, Charles Univ. of Praha, Masaryk Univ. of Brno, Univ. v Ljubjani, Univ. of Bucharest, Univ. of Craiova, Univ. of Latvia, Univ. de Stiinge Agricole, Vilnius University, Sofia University, Tirana University.

In addition, the Univ. of Lund (Sweden) has joined to the program in 1992.

Since 1991, altogether 41 student have already taken place in different exchange programs, and studied modern disciplines of current biology for 6 months at western universities; The accompanying intensive practice of a foreign language is also being definitely advantageous for them. After these studies we collected unanimously favorable accounts of their experiences, and there is great interest on part of the students for such possibilities, indeed.

The staff exchange programs included 40 members of our university and usually lasted for 2-4 weeks. These experiences, i.e. to study the modern systems of higher education at collaborating institutes were also important for many (especially in the view of current needs for restructuring the system of higher education in Hungary, and the reintroduction of organized postgraduate training at Hungarian universities).

It is also important that more and more colleges from the European Community come to Szeged and teach biology for our students; For example in 1993, two colleges from UK, one from France and one from Denmark will visit us for 2-4 weeks.

As another goal of the program our 10 departments shared parts of the financial support and won circa 50 thousand ECU for expenditures at Szeged, i.e. for purchasing equipments, books, journals, and other things for education.

According to our experience the past activities contribute significantly to the achievements originally expected from the project (number of updated teachers, number and level of students involved, restructured courses, new subjects, and kind of upgraded facilities). We hope that this exemplary collaboration will continue in the future and contribute to the development of the quality of higher education of biology at Szeged.

Prof. ATTILA BARANYI
TEMPUS Coordinator
Szeged

ACTA BIOL. SZEGED. 39. 149-152. (1993)

CHRONICLE

Personalia

KÁROLY GULYA Ph.D., senior research associate from the Central Research Laboratory, Szent-Györgyi Albert Medical University, Szeged, was appointed to chair the Department of Zoology, József Attila University, from July 1, 1993, as associate professor.

Associate Professor Dr. ATTILA BARANYI (Department of Comparative Physiology) was elevated to the position of professor.

Assistant Professor Dr. MAGDOLNA ÁBRAHÁM (Department of Biochemistry) was elevated to the position of associate professor.

Scientific degree

Associate Professor Dr. JÁNOS NEMCSÓK, with the thesis "Research into the biochemical effects of xenobiotics on fish" took the degree of doctor in biological science.

GYÖRGY PÁLFI (Department of Anthropology) a research fellow of the Hungarian Academy of Sciences, received his Ph.D. from the University of Province (Aix-en-Province, France) with his thesis entitled "Diseases, Activities and Environment of Ancient Populations in Central and Western Europe: A Comparative Paleopathological Approach".

Honours

Associate Professor Dr. PÉTER MARÓI (Department of Genetics), Dr. ISTVÁN KISS, Dr. JÁNOS GAUSZ, Dr. HENRIK GYURKOVICS (Biological Research Center of the Hungarian Academy of Sciences, Szeged) and Prof. Dr. JÁNOS SZABAD (Department of Biology, Szent-Györgyi Albert Medical University, Szeged) awarded academic prizes for their research work in the genetics of *Drosophyla*.

Anniversary

Professor Dr. ISTVÁN SZALAI, who was the head of the Department of Plant Physiology 1952-1973 and the editor of Acta Biologica Szegediensis from 1957 to

1974 turned 81 in 1993. This year the József Attila University conferred him the "Diploma of fifty years' standing".

Scientific session

An international congress, entitled "The origin of Syphilis in Europe: Before or after 1493?", was co-organized by the Centre Archéologique du Var (Toulon), the University of Provence (Aix-en-Provence) and the Department of Anthropology of József Attila University (Szeged), from 25 to 28 November 1993 in Toulon. On the occasion of the 500th anniversary of the return of Columbus' crew, this congress, dedicated to CECIL J. HACKETT, was devoted to discussing the history and paleopathology of human treponematoses and the recent research on this topic.

Establishment

PÁL GREGUSS medal

The 5th Symposium for Plant Anatomy and the Greguss-centenary was held at the Department of Botany of József Attila University on August 25-26, 1989. Associate Professor Dr. SÁNDOR GULYÁS, the student and successor of Professor Dr. PÁL GREGUSS, had the medal made for the occasion of this centenary. The medal is the work of ANDRÁS LAPIS: made either of bronze or silver, with a 44 mm diameter, 3 mm thickness, and weight of 42 g.

On the frontside of the medal is the relief of the face of PÁL GREGUSS, with his name and the following inscription: "For the 100th anniversary of his birth 1889-1989".

On the reverse side there is a three dimensional shape of the trunk of a three year old linden tree. This was a favourite drawing of GREGUSS, the world famous xylotomist. Above the linden trunk is linden fruit with bracts, under it two leaves can be seen. Beside the fruit appear the following words: "Knowledge, Love, Health". These words were often mentioned by Professor GREGUSS as the three treasures of the world.

The GREGUSS memorial medal was awarded for the first time at the 8th Symposium for Plant Anatomy to ZITA RUDNER, a young anatomist, she received this medal together with the award from fund of "Development for Plant Anatomy".

AMBRUS ÁBRAHÁM memorial medal

On the occasion of the 100th anniversary of the birth of neurobiologist Professor Dr. AMBRUS ÁBRAHÁM, member of the Hungarian Academy, in 1993 a medallion was established by the József Attila University, Szeged, and the Biological Section of the Hungarian Academy of Sciences.

The medallion will be awarded to researchers who receive international recognition in the field of neurohistology and who help on the international collaboration of the Department of Zoology of József Attila University, Szeged.

The medallion, made by sculptor SÁNDOR TÓTH, is 10.3 cm in diameter. On the frontside of the medal is the relief of the face of AMBRUS ÁBRAHÁM and the following inscription: "ÁBRAHÁM AMBRUS neurobiologist, Tusnád 1893, Szeged 1989". The photocopy of the medallion is shown below.

The "ÁBRAHÁM AMBRUS medallion" was awarded for the firs time to former students Professor Dr. EMIL MINKER and member of the Hungarian Academy Professor Dr. JÓZSEF HÁMORI, as well to Professor Dr. SÁNDOR BENDE, a former colleague from the Teachers' Training College in Eger.

Foundation of Department

Institute of Biotechnology, Szeged, BAY ZOLTÁN Foundation for Applied Research

The BAY ZOLTÁN Foundation for Applied Research was founded in October 1993 by the National Council for Technical Development with a capital of 1 billion Hungarian Forints. The Foundation has the aim of developing a new network of institutes where problem oriented applied research will be carried out. These institutes will fill the gap between research and industry. The German Fraunhofer Institutes were taken as models for the BAY ZOLTÁN Institutes.

One of these new institutes is the Institute of Biotechnology of the BAY ZOLTÁN Foundation. The institute was established in May 1993. It is located near to the Biological Research Center of the Hungarian Academy of Sciences, Szeged and the Biological Faculty of József Attila University, Szeged. These institutes and departments provide an internationally recognized research background for the Institute of Biotechnology.

The Institute of Biotechnology of the BAY ZOLTÁN Foundation has started its activities in two fields of research and development. One is the use of immobilized enzymes and microorganisms for the production of valuable products from agricultural and industrial wastes and by-products. The other is the development of clinical diagnostic kits based mainly on molecular biological methods for the detection of different genetically inherited and infectious diseases.

The senior researchers of the Institute of Biotechnology have internationally recognized experience in biotechnology, in the monitoring of water purity, in using fish as test objects, and in different areas of molecular biology. The many Hungarian and international patents taken out by our staff members prove their innovative ability.

The head of the BAY ZOLTÁN Institute is Associate Professor Dr. JÁNOS NEMCSÓK.

Index